

**Quantitative and Qualitative Inquiry into the Use
of Noninvasive Ventilation to Treat Acute Asthma
in Adults: A Multi-Site Study**

**Elyce Green
RN, BN (Hon), BClinPrac, MN (Crit Care)**

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**School of Nursing, Midwifery and Indigenous Health
Faculty of Science, Charles Sturt University**

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Certificate of Authorship

I hereby declare that this submission is my own work and, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma at Charles Sturt University or any other educational institution, except where due acknowledgment is made in the thesis. Any contribution made to the research by colleagues with whom I have worked at Charles Sturt University or elsewhere during my candidature is fully acknowledged.

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Name: Elyce Green

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Date: 21/04/2018

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Publications, Conference and Symposium Presentations Resulting from the Thesis

Publications

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Abstract

This research project examined the use of noninvasive ventilation (NIV) to treat acute exacerbations of asthma in adults in a regional local health district in New South Wales, Australia. International guidelines are currently inconsistent in their recommendations for the use of NIV to treat acute asthma in adults due to limited evidentiary support. Despite this, NIV is being used as a treatment for acute asthma in Australia. It is not conclusively known whether NIV provides better clinical outcomes for patients compared to standard medical therapy, or the influence of context on nurses' ability to use this treatment.

The aim of this project was to examine whether NIV provided better clinical outcomes for adult patients with acute asthma compared to those who received standard medical therapy. It was, however, also recognised that the efficacy of a treatment is not limited to its clinical application, but also results from the effects of context. As a result, this research project aimed to examine where and how often NIV was being used to treat acute asthma, if the use of NIV for acute asthma led to improved clinical outcomes for patients, and the experiences of the nurses who used NIV.

This project was guided by the philosophy of pragmatism, a paradigm that determines value by defining practical usefulness. Using pragmatism as a foundation, a mixed methods project was designed. Specifically, a sequential explanatory design was used incorporating two distinct phases – quantitative and qualitative – which were integrated at specified points in the project. The quantitative phase of the project was conducted first and involved retrospective data collection from patients' medical records to determine the short-, medium- and long-term outcomes of adult patients who had been admitted to hospital with acute exacerbations of asthma and received NIV as a treatment, compared to those who received standard medical treatment. Questions that emerged from the quantitative data were then used to design a qualitative project phase. The qualitative phase used semi-structured interviews with registered nurses to explore their experiences using technology such as NIV and the effect those experiences and their individual context had on their practice.

In the five-year retrospective period examined, there were 71 adult patients admitted with acute exacerbations of asthma who were eligible for NIV. Of those patients, 63% received NIV treatment. In regards to the analysis of outcomes, NIV did not have a significant effect

on pH or pCO₂ but did have a significant effect on respiratory rate. Using the results from the quantitative data analysis, interviews were conducted with nine nurses working in critical care units from the same area. The interview findings suggest there are several factors that influence the use of NIV as a treatment that do not relate to the technology itself; these include lack of education, isolation, fear, support and mentorship, taking ownership, leadership and intuition.

NIV was used commonly for the treatment of acute exacerbations of asthma in this regional local health district in Australia, but not for all patients who met the criteria for the treatment. This research demonstrates that the use of NIV as a treatment for acute exacerbations of asthma may be beneficial, but it is equally important for healthcare organisations to examine the way in which treatments are implemented into practice or their efficacy may be lost.

Chapter 1: Introduction, Context and Background

1.1 Introduction

This thesis details research undertaken to investigate if noninvasive ventilation (NIV) provides better clinical outcomes for acute exacerbations of asthma compared to standard medical therapy. In recognition of the influence of context on the ability to provide treatment, the project additionally sought to explore nurses' experiences with using NIV. A mixed methods design was used with the researcher first collecting and analysing quantitative data to investigate the frequency of NIV use for acute exacerbations of asthma, the location in which it was used and to compare the outcomes of patients who received NIV for acute asthma to those who did not. Data were retrospectively collected from the medical records of patients who presented to emergency departments (ED) in nine sites within the Murrumbidgee Local Health District (MLHD), New South Wales (NSW), Australia. The quantitative data were then used to guide the qualitative phase of the project. Semi-structured interviews with registered nurses (RN) working in nine EDs were conducted to explore their experiences of using technology such as NIV and the effect their individual contexts had on their practice. The integration of both phases of the project was then undertaken to provide a broad view of the use of NIV in practice.

The chapter begins with an exploration of the context of asthma including its economic and physiological burden. The use of NIV will then be explored and its role in the treatment of asthma identified. Finally, a brief overview of the effect of healthcare context on treatment variability will be presented. This chapter ends with an overview of the methodology used in this research project and the content of the subsequent chapters of the thesis.

1.1.1 Definition of Asthma

Asthma is a complicated disease process that has had an evolving definition since identification of the disease. In 1959, a report on the terminology, definitions and classification of chronic pulmonary emphysema and related conditions referred to the diagnosis of asthma as:

The condition of subjects with widespread narrowing of the bronchial airways, which changes its severity over short periods of time either spontaneously or under treatment and is not due to

cardiovascular disease (Fletcher, Gilson, Hugh-Jones, & Scadding, 1959, p. 296).

By 2010, asthma was defined as:

A chronic inflammatory disorder of the airways in which many cells and cellular elements play a role, including mast cells, eosinophils, T lymphocytes, macrophages, neutrophils, and epithelial cells. In susceptible individuals, inflammation causes recurrent episodes of wheezing, breathlessness, chest tightness, and coughing particularly at night or in the early morning. These episodes are usually associated with widespread but variable airflow obstruction that is often reversible either spontaneously or with treatment. The inflammation also causes an associated increase in bronchial hyperresponsiveness to a variety of stimuli (Lugogo, Que, Fertel, & Kraft, 2010, p. 884).

More recently, the Global Initiative for Asthma (2017, p. 14) released a report with a broad, consensus definition of asthma as:

A heterogenous disease, usually characterised by chronic airway inflammation. It is defined by the history of respiratory symptoms such as wheeze, shortness of breath, chest tightness and cough that vary over time and in intensity, together with variable expiratory airflow limitation.

This new definition reflects the growing number of asthma phenotypes described in the literature and the subtle variation in treatment required for each phenotype (Global Initiative for Asthma, 2017). The general characteristics required for a probable diagnosis of asthma include: more than one symptom (wheeze, shortness of breath, cough, chest tightness), symptoms worse at night or early in the morning, symptoms that vary over time and in intensity, symptoms that are triggered by viral infections, exercise, allergen exposure, changes in the weather, laughing or irritants such as car exhaust fumes (Global Initiative for Asthma, 2017, p. 15).

1.1.2 Global Context of Asthma

The Global Asthma Network estimates the number of people with asthma globally may be as high as 334 million (Asher et al., 2014). Unfortunately, there is no standardised method of data collection for asthma statistics internationally and therefore the estimated rates globally are based on the Global Burden of Disease Study undertaken from 2008 to 2010 (Asher et al., 2014). Regarding the distribution of asthma across the age spectrum, it is estimated that children most commonly experience asthma exacerbations. The International Study of Asthma and Allergies in Childhood, undertaken between 2000 and 2003, found that

approximately 14% of the world’s children were likely to have had symptoms of asthma in the previous year (Asher et al., 2014, p. 18). The highest prevalence was found in Australasia, Europe, North America and South Africa (Lai et al., 2009, as cited in Asher et al., 2014, p. 16).

The World Health Organization’s (WHO) World Health Survey 2002–03 found that 4.5% of those aged 18–45 years reported a physician’s diagnosis of asthma and 8.6% of the same cohort reported they had experienced symptoms of asthma in the previous 12 months (WHO as cited in Asher et al., 2014, p. 20). The highest prevalence rates were seen in Australia, Northern and Western Europe and Brazil as illustrated in Figure 1.1. There is little information available on the prevalence of asthma in middle-aged and older adults. This may be due partially to the difficulty in differentiating asthma from chronic obstructive pulmonary disease (COPD) now described as asthma-COPD overlap (Global Initiative for Asthma, 2017, p. 90). There are no standardised international comparisons of asthma in middle-aged and older adults.

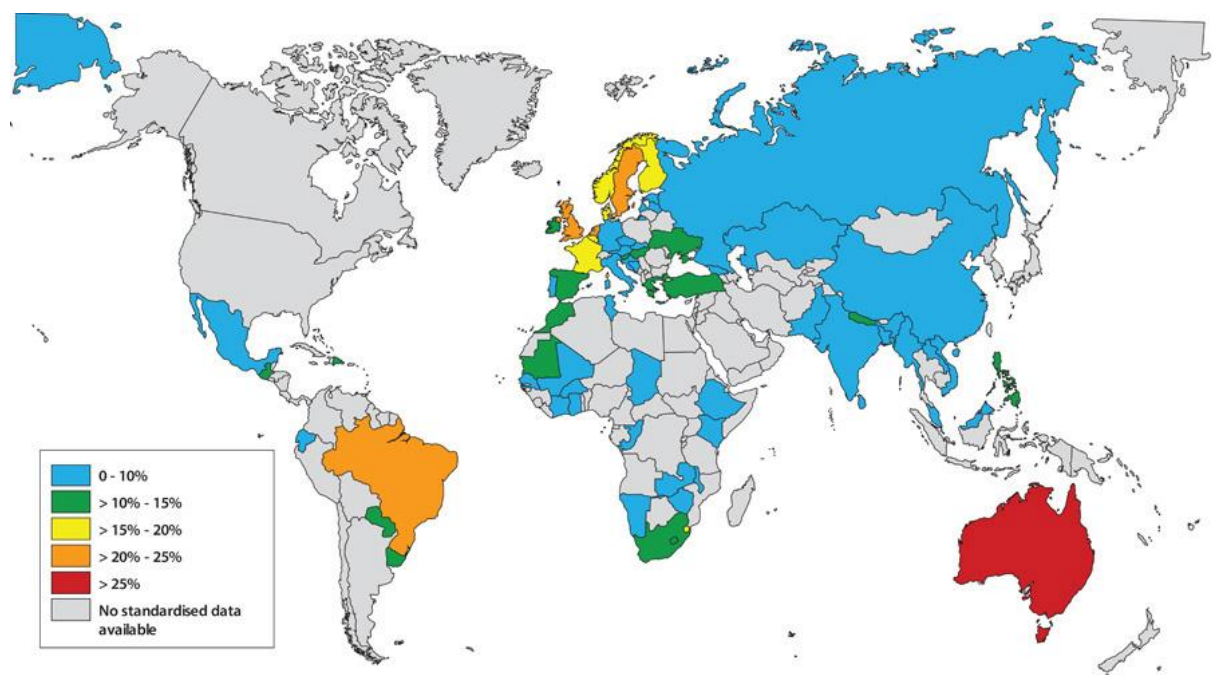


Figure 1.1 Prevalence of symptoms of asthma in the past 12 months among persons aged 18–45 years in 70 countries

Source/Note: World Health Survey 2002–03 (To et al., 2012 as cited in Asher et al., 2014, p. 18)

The burden of asthma, measured by disability and premature death, is greatest in children aged 10–14 years and older adults aged 75–79 years (Asher et al., 2014, p. 20). The burden is similar in males and females at ages below 30–34 years but at older ages the burden is higher in males which continues to occur with increasing age (Asher et al., 2014, p. 20). The Global Burden of Disease Study estimated that asthma was the 14th most important disorder in terms of global years with disability, yet asthma has a relatively low level of mortality, contributing to less than 1% of all deaths in most countries worldwide (Asher et al., 2014, p. 20). The Global Burden of Disease Study estimated that age-standardised death rates from asthma fell by about one third between 1990 and 2010 (Asher et al., 2014, p. 31). The available international evidence indicates the highest rates of asthma mortality per 100,000 population for people aged 5–34 years are found in Mauritius, Kuwait, USA, UK and Australia (Australian Centre for Asthma Monitoring [ACAM], 2011). These mortality rates are represented graphically in Figure 1.2. Unfortunately, it is difficult to make international comparisons due to the lack of standardised data collection and reporting. Furthermore, it should be taken into account that the data currently being used to estimate rates of asthma are probably under reported.

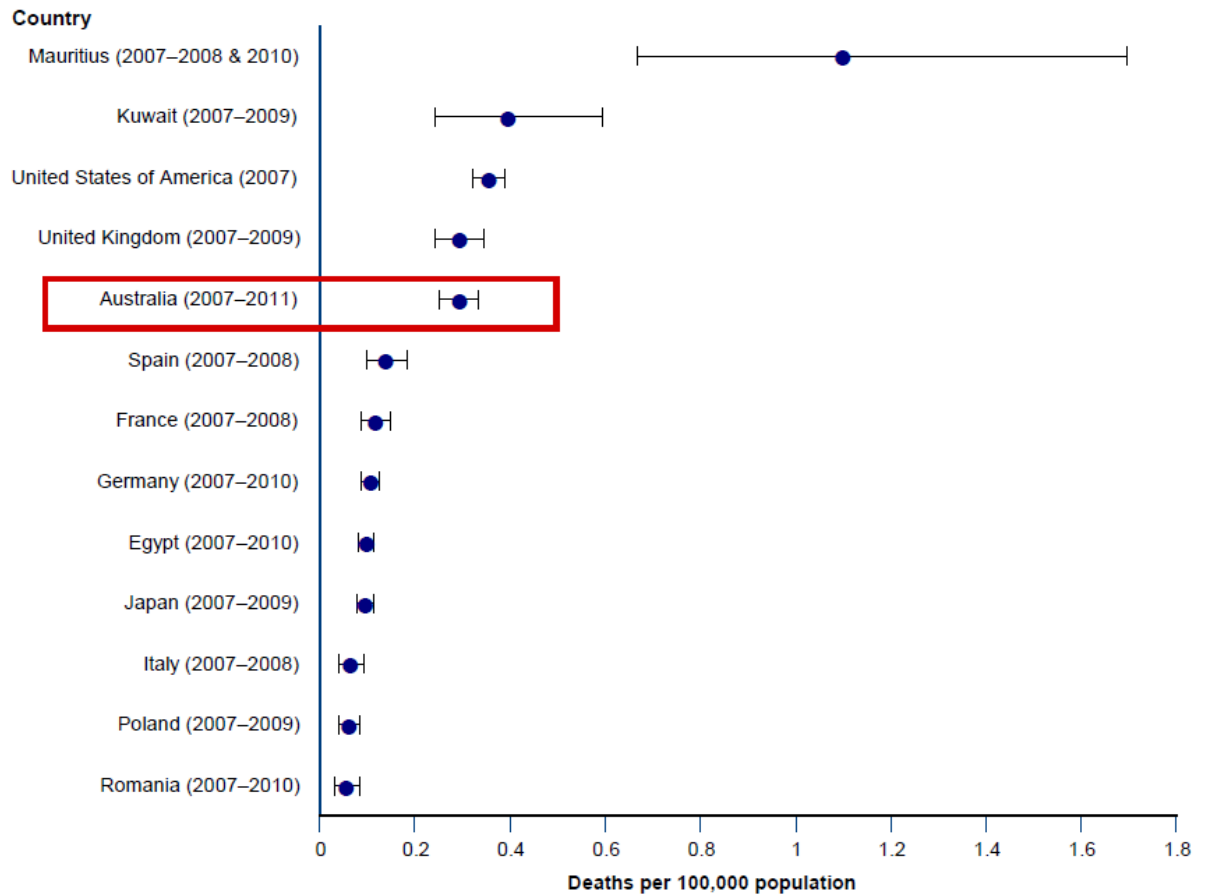


Figure 1.2 World ranking of asthma mortality rates, people aged 5–34 years, 2007–2011
Source/Note: Australian Institute of Health and Welfare et al. (AIHW), 2014, p. 9

Internationally, hospital admissions for acute asthma vary significantly between countries. Admission statistics are also not available for many countries which makes international comparisons impossible. In European countries, it is estimated asthma contributes 0.6% of hospital admissions and 0.4% of all inpatient bed-days. Figure 1.3 shows age-standardised admission rates for asthma for earliest and latest available year in European countries ordered by the latest admission rate.

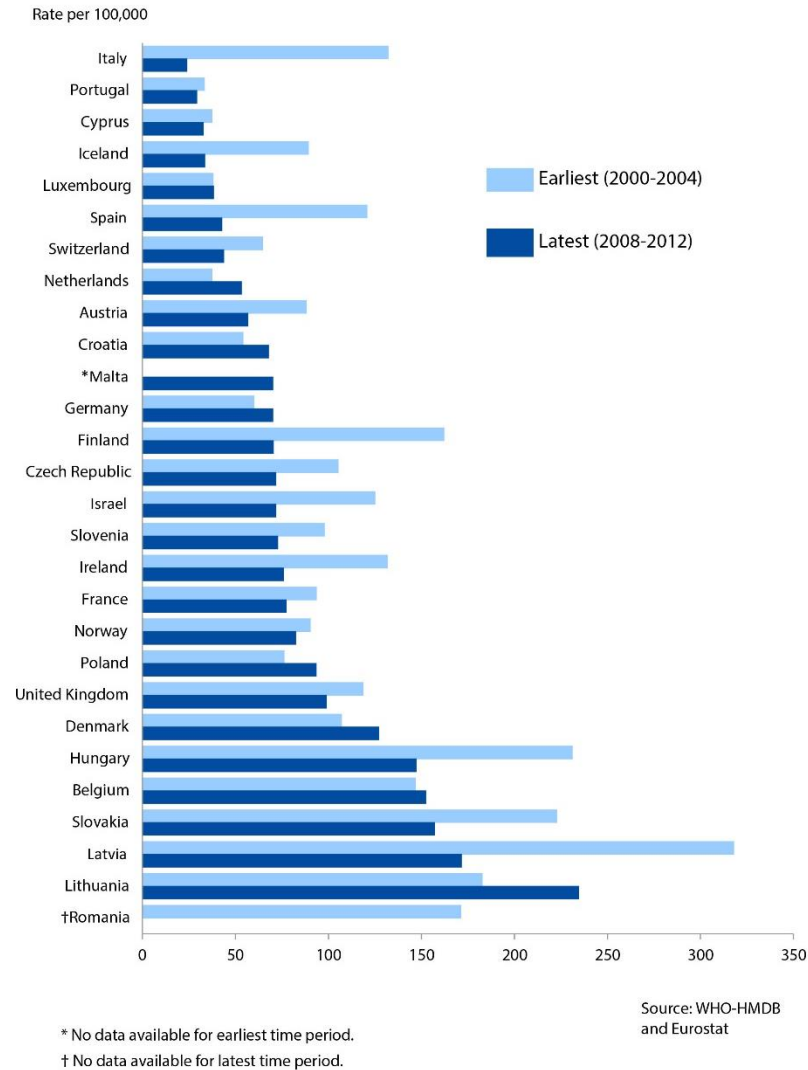


Figure 1.3 Age-standardised admission rates for asthma for earliest and latest available year in European countries ordered by latest admission rate
 Source/Note: WHO-HMDB and Eurostat (as cited in Asher et al., 2014, p. 23)

1.1.3 Australian Context

The most recent Australian asthma data from the 2007–2008 National Health Survey were used to estimate that 3,888,952 (19%) Australians have been diagnosed with asthma at some point in their lives (ACAM, 2011). The same data were used to estimate that 2,049,086 Australians had current asthma, representing about 10% of the population (ACAM, 2011). Methods to collect asthma data from individual states have not been standardised and it is therefore difficult to compare the rates of asthma across different states in Australia. The AIHW compared several data sources from Australia to approximate the prevalence of

asthma in adults and demonstrated that the prevalence of asthma in adults decreased by 0.18 percentage points per year between 2000 and 2009 (ACAM, 2011, p. 17).

Australian mortality rates due to asthma peaked in the 1950s, mid-1960s and late 1980s but have since declined substantially (AIHW et al., 2014). The increase in the 1960s and 1980s in a number of high-income countries was attributed to the introduction of high-dose isoprenaline inhalers as an asthma reliever medication, which can have toxic effects on the heart during asthma attacks, and the use of fenoterol, another inhaled asthma medication with potential cardiac toxicity (Asher et al., 2014, p. 31). By 2003, the mortality rate caused by asthma had dropped by 70% to 1.6 per 100,000 population and as of 2011 was 1.5 per 100,000 population in Australia (AIHW et al., 2014). The decrease in mortality rates from asthma despite a lack of change in asthma prevalence may be attributed to the introduction of asthma management guidelines, changes in the use and availability of pharmaceuticals, policy initiatives at state and national levels and better diagnosis of asthma and COPD-overlap (Asher et al., 2014; AIHW et al., 2014).

In NSW, a comparison of the results from the 2004–2005 National Health Survey to those reported in 2007–2008 showed that the prevalence of asthma had significantly increased from 16.8% to 19.9% (ACAM, 2011). A survey conducted in NSW examined the responses of 728 residents regarding their diagnosis of asthma (Reddel, Bosnic-Anticevich, Toelle, Jenkins, & Marks, 2007). Similar to the findings of the National Health Survey, the researchers found that people with current asthma rated their health as worse than those without current asthma. Predictors of poor asthma control included age, gender, current smoker, living in more disadvantaged areas, remoteness, employment status, concession card holder, health insurance, education and non-English speaking background (Reddel et al., 2007). In regards to hospital treatment it was shown that 28% of adults and 62% of children had experienced at least one episode of asthma requiring urgent health care in the last 12 months (Reddel et al., 2007).

1.1.4 Murrumbidgee Local Health District Context

The Murrumbidgee Local Health District (MLHD) is an area of around 125,561 square kilometres located in south-east NSW. The estimated resident population is 242,840 as of June 2016 (NSW Ministry of Health (MLHD), n.d.). It comprises inner regional and outer regional areas, and one remote area, and includes 32 health facilities, as shown in Figure 1.4

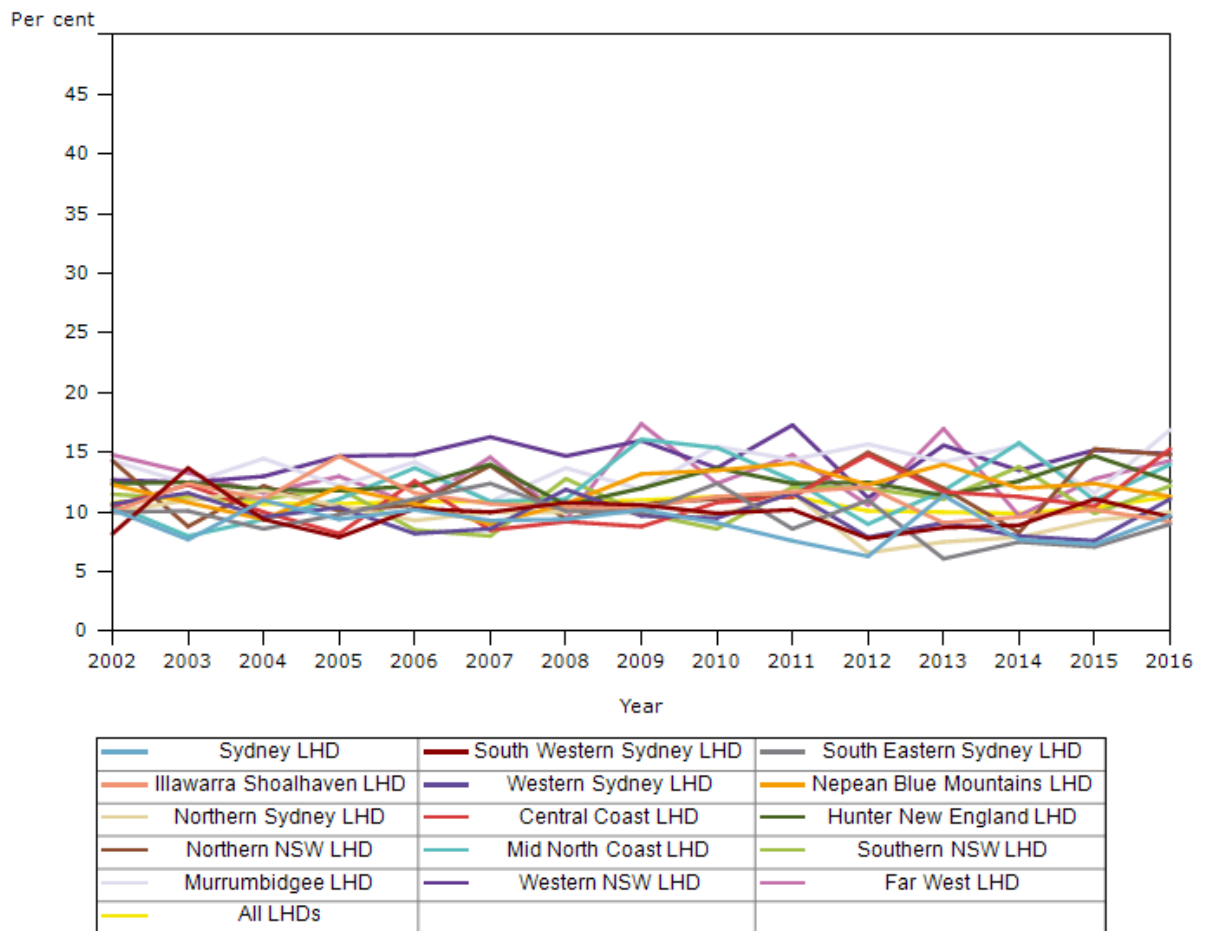


Figure 1.5 Comparison of current asthma diagnosis rates in people aged over 16 years in NSW 2002–2016, by LHD

Source/Note: NSW Ministry of Health, 2017d

High disease prevalence often places a significant strain on healthcare resources. This is demonstrated in relation to asthma by the high rate of hospitalisations due to the disease. The MLHD has maintained the highest number of asthma hospitalisations per 100,000 population since 2007, as illustrated in Figure 1.6 (NSW Ministry of Health, 2017b). This may be reflected by the burden of disease associated with this illness, as will be discussed later in this chapter.

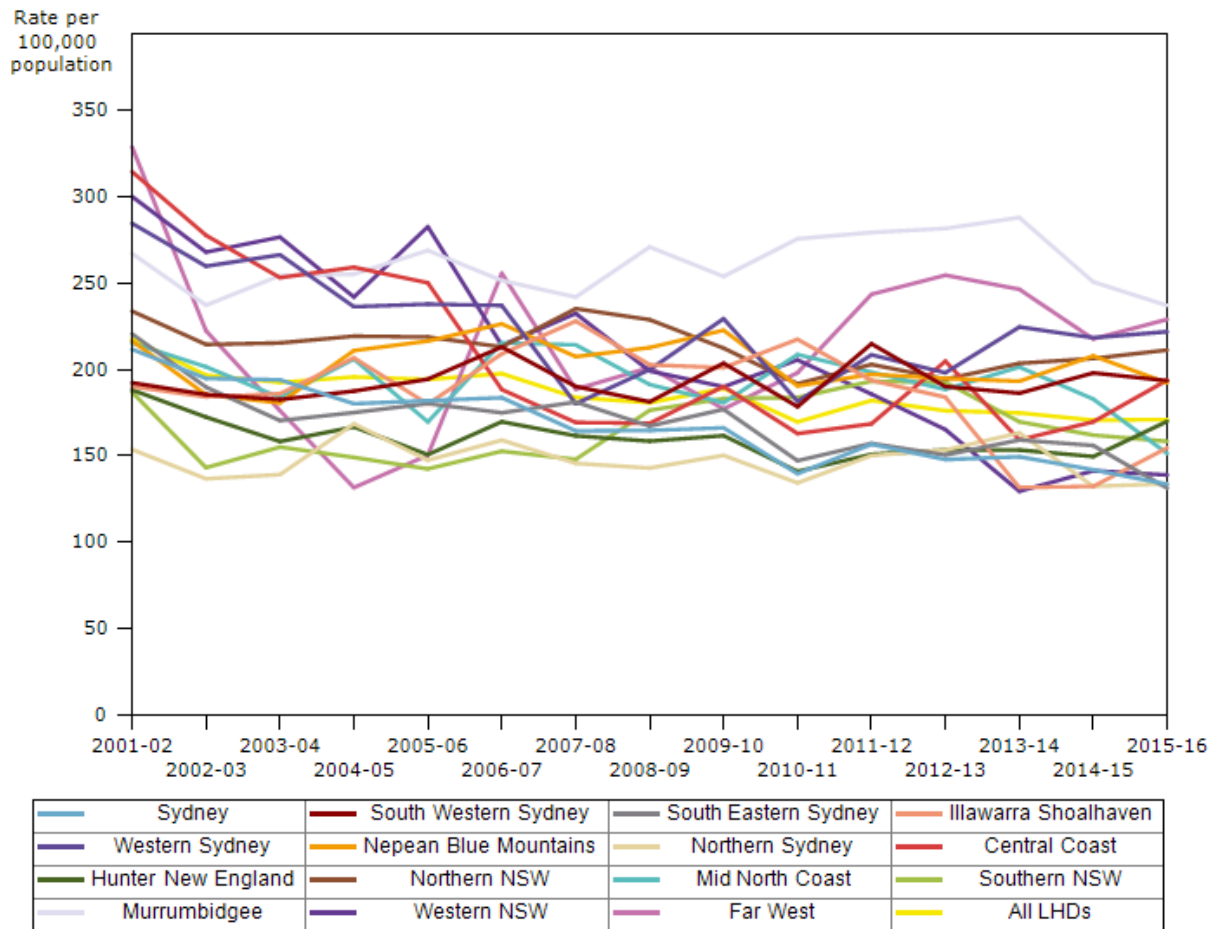


Figure 1.6 Asthma hospitalisations comparison by LHD in NSW, 2001–2002 to 2015–2016
 Source/Note: NSW Ministry of Health, 2017b

Some reasons for the high rate of asthma hospitalisations in the MLHD may be the high rate of asthmatics who currently smoke and the occurrence of thunderstorm asthma in this area (Girgis et al., 2000; NSW Ministry of Health, 2017e). Thunderstorm asthma is a phenomenon that has been reported in limited locations internationally including various sites in the UK (Alderman, Sloan, & Basran, 1986; Campbell-Hewson et al., 1994; Packe & Ayres, 1985); Calgary, Canada (Wardman, Stefani, & MacDonald, 2002); Melbourne and Wagga Wagga, Australia (Bellomo et al., 1992; Girgis et al., 2000); Athens, Greece (Illias, 1998); and Naples, Italy (D’Amato, Cecchi, & Liccardi, 2008). Research has been unable to definitively describe the cause of thunderstorm asthma but it is hypothesised to be a result of the combination of unique weather associated with thunderstorms interacting with aeroallergens (Dabrera et al., 2013). Wagga Wagga has had several epidemics of thunderstorm asthma since 1997 and this phenomenon continues to contribute to the high rate of asthma admissions (Girgis et al., 2000).

The factors unique to the MLHD that cause a high prevalence rate of asthma and subsequently a high rate of hospitalisations also have an effect on mortality rates. As previously discussed, asthma globally does not have a high mortality rate, although, in the MLHD, asthma deaths have traditionally been higher than the state average. The number of deaths attributed to asthma in the MLHD have declined overall since 2001, reaching a rate equal to that of the rest of the state in 2014–2015, as demonstrated in Figure 1.7.

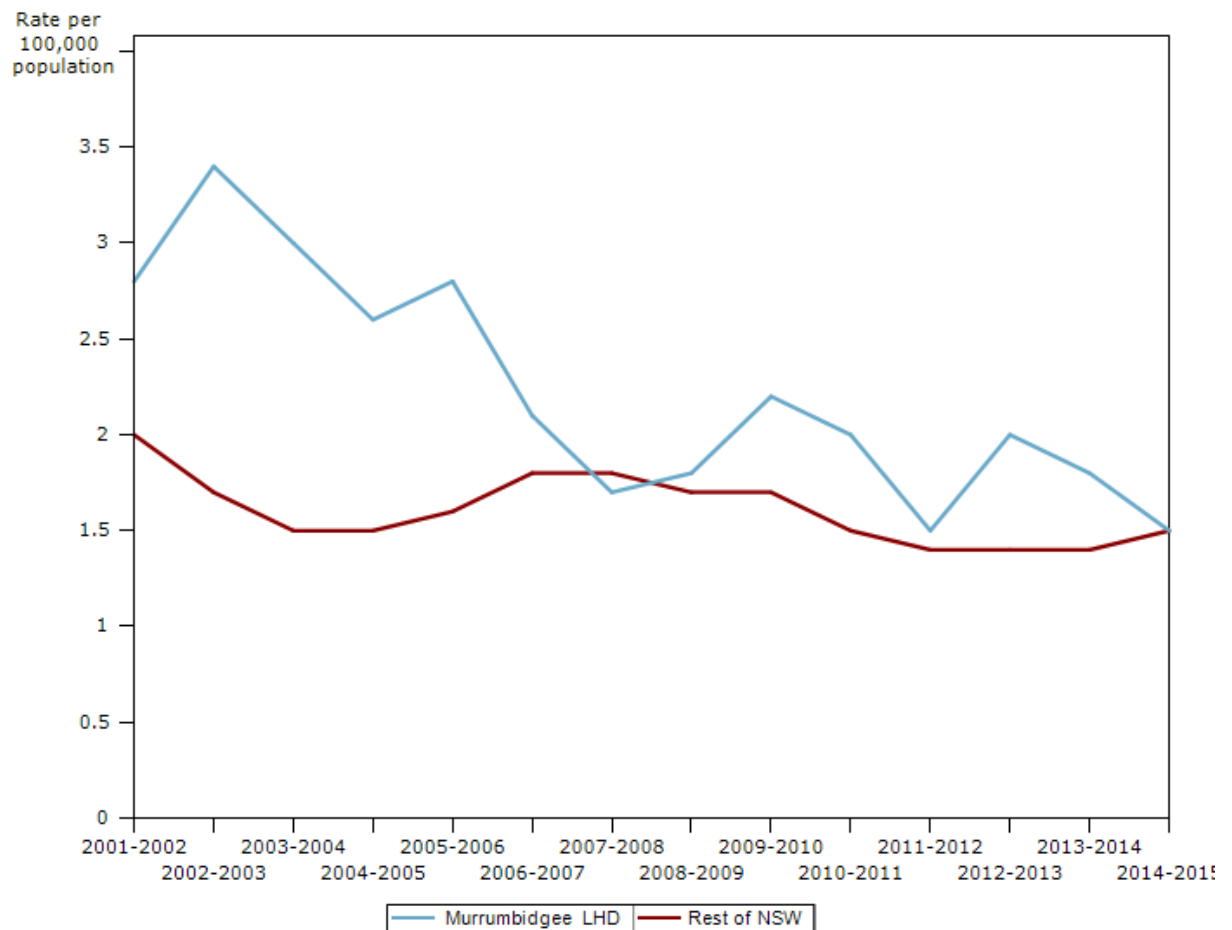


Figure 1.7 Asthma deaths in the MLHD compared to the rest of NSW, from 2001–2002 to 2014–2015

Source/Note: NSW Ministry of Health, 2017a

1.1.5 Economic Burden

It is difficult to determine the exact economic impact of asthma due to the requirement to incorporate both direct and indirect monetary impacts. Despite this, the available data indicate that asthma creates a significant economic burden. From 2001, the significant direct and indirect costs of asthma were recognised by Malone and Armstrong (2001) in the USA. It was estimated that at this time the national cost of asthma in the USA exceeded US\$10

billion per year (Malone & Armstrong, 2001). A later study estimated that in 2007 the total cost of asthma to society in the USA was US\$56 billion for the year (Asher et al., 2014, p. 37). In Europe, it has more recently been estimated that asthma costs in excess of €19,000 million per year without accounting for loss of work productivity (Domínguez-Ortega, Phillips-Anglés, Barranco, & Quirce, 2015). Examining the cost of asthma per patient in the Asia-Pacific region, annual direct costs were estimated to range from US\$108 in Malaysia to US\$1010 in Hong Kong (Lai, Kim, Kuo, Spencer, & Williams, 2006).

In Australia, between 2004 and 2005, 59% of asthma expenditure was attributed to prescription medications which was substantially higher than the proportion of total health expenditure attributed to prescription pharmaceuticals. Only 16% of asthma expenditure was attributed to inpatient care compared with total allocated health expenditure (ACAM, 2011). In 2001, Australia spent \$693 million on asthma accounting for 1.4% of the total healthcare expenditure (ACAM, 2005). In the 2004–2005 financial year in Australia, the amount of direct expenditure allocated to asthma was \$606 million (ACAM, 2011). The median estimated cost of asthma for an individual is \$89 per person per year (range \$0–\$4882) (Kenny, Lancsar, Hall, King, & Chaplin, 2005). The indirect costs of asthma in Australia are not currently known.

Many studies report that better prevention and treatment of asthma would directly reduce costs associated with this disease (Domínguez-Ortega et al., 2015; Khadadah, 2013; Stock et al., 2005). People suffering from moderate to poorly controlled asthma tend to use more healthcare resources and have greater medical costs compared to those without asthma (Accordini et al., 2013; Gold et al., 2014; Gold, Yeung, Smith, Allen-Ramey, Nathan, & Sullivan, 2013). Increasing patient compliance to asthma treatment will have a similarly beneficial effect on the cost of asthma (Bender & Rand, 2004). One study, conducted over 15 countries, assessed the local cost of asthma exacerbations managed in either primary or secondary care (Lane, Molina, & Plusa, 2006). It was found that the cost of exacerbations was significantly higher in secondary care than in primary care. The researchers also observed that as the severity of the exacerbation increased so did secondary costs, whilst primary costs remained relatively constant (Lane et al., 2006). The results published by Lane et al. (2006) not only reveal the significant cost of asthma, but also the ability to alter costs through the provision of appropriate preventative health care.

The notion of reducing the cost of asthma by preventative treatment in primary care or effective, timely treatment in secondary care was further explored by Williams, Lloyd, Watson, and Rabe (2006). They examined health care-related costs for patients with asthma across seven countries in Europe and found that around half the expenditure was due to unscheduled care (Williams et al., 2006). Simonella, Marks, Sanderson, and Andrews (2006) attempted to determine the cost-effectiveness of averting the burden of disease in Australia. They calculated that providing patients with optimal treatment and encouraging optimal compliance would avert 69% of the financial burden of asthma and would significantly reduce disability (Simonella et al., 2006).

1.1.6 Impact on Quality of Life

Traditional measurements of disease including mortality and morbidity are limited in their ability to describe the impact of a disease on society. By measuring health-related quality of life, data can be obtained that describe qualitative and individual effects of a disease (ACAM, 2005). Several studies have indicated there is an association between asthma and poor quality of life (Goldney, Ruffin, Fisher, & Wilson, 2003; Guilbert et al., 2011; Miedinger et al., 2011). There are a number of factors associated with asthma that have an impact on individuals' quality of life including sleep disturbance, reduced activity days, restricted physical activity, reduced functional ability and days lost from work or school (ACAM, 2011). Sleep disturbance in people suffering from asthma is a marker of poor disease control but is a common phenomenon reported by people with asthma and was reported in the summer of 2003–2004 to be experienced by 22.5% of adults and 20.4% of children over a four- week period (Marks et al., 2007).

In regards to self-assessed health status, the presence of asthma has previously been shown to have an effect on burden of ill health and impaired quality of life in the community (Ampon, Williamson, Correll, & Marks, 2005). This trend is also seen in children. In the Longitudinal Study of Australian Children, similar results were found as children with asthma continually rated their health worse than children without a diagnosis of asthma (ACAM, 2009). These results have also been reflected by findings in the USA (Chen et al., 2007; Sullivan et al., 2013), France and Spain (Doz et al., 2013).

Psychological health also seems to be affected by a diagnosis of asthma with one Australian study finding higher rates of depression in patients with asthma (Wilson et al., 2010). This

phenomenon is not a new concept and was reported in 2003 by Goldney et al. (2003). The 2004–2005 Australian Health Survey found that people with current asthma were more likely to have high levels of psychological distress and 22.3% more likely to rate their distress as high or very high compared to people without asthma (ACAM, 2007, p. 52). This has similarly been observed in the USA where the prevalence of psychological distress was reported as 2.5 times higher for adults with asthma compared to those without asthma (Oraka, King, & Callahan, 2010). Another American study found occupational asthma to be moderately associated with psychological distress measures (Miedinger et al., 2011). The World Mental Health Survey also reported that those who had ever received a doctor's diagnosis of asthma were 1.7 times more likely to have generalised anxiety, agoraphobia or panic disorder and 1.8 times more likely to have post-traumatic stress disorder than those who had not received a doctor's diagnosis of asthma (Scott et al., 2007).

Loss of time at work or school also has a significant impact on people with asthma. The 2007–2008 National Health Survey Australia reported the proportion of people with current asthma who had taken time off work, school or study in the previous 12 months was 24.2%. Furthermore, even when people with asthma present to work, they may have increased work impairment resulting in a loss of productivity (Williams et al., 2006).

Asthma has a noteworthy prevalence internationally, nationally and locally in the MLHD making it a topic of importance. The significant economic and physiological burden resulting from asthma also makes it an issue worthy of investigation. Methods of treatment should be investigated to determine best practice to guide clinicians when treating patients with acute exacerbations of asthma so that safe, effective treatment can be provided. The pathophysiology of asthma and potential role of NIV in treatment will now be discussed.

1.2 Pathophysiology of Asthma

Asthma has traditionally been classified into three different diagnostic categories: extrinsic asthma, intrinsic asthma and asthma associated with COPD (McConnell & Holgate, 2000, p. 3–4). Extrinsic asthma is typically a type one immediate hypersensitivity reaction, involving the production of immunoglobulin E to specific antigens. Intrinsic asthma tends to present earlier in life and is diagnosed in individuals with airflow obstruction in whom there appears to be no antigenic or chemical factor causing the airway inflammation and no history of smoking. Asthma associated with COPD was once labelled as asthma-COPD

overlap syndrome but this definition has been superseded and the coexistence of asthma and COPD is now referred to as asthma-COPD overlap to recognise this condition as a combination of disease phenotypes, not a single disease entity (Global Initiative for Asthma, 2017, p. 90).

This particular diagnostic category commonly occurs in patients over the age of 40 years who show clinical symptoms of both asthma and COPD. Although these three diagnostic categories continue to be used, a significant amount of work has been done in recent years to differentiate the phenotypes of asthma (Wenzel, 2012; Wu et al., 2014). As a result, asthma is now more commonly being viewed as a broad syndrome rather than one specific disease.

This research project is focused on the manifestations of an acute asthma exacerbation without phenotype differentiation. It is, however, beneficial to have an understanding of the pathogenesis of the most commonly described phenotypes of asthma and therefore, will be described briefly below.

- Allergic asthma: often commences in childhood and is associated with a past and/or family history of allergic diseases such as eczema, allergic rhinitis, or food/drug allergy. Examination of the sputum of these patients before treatment often reveals eosinophilic airway inflammation.
- Non-allergic asthma: occurs in people who have asthma without an associated allergy. The cellular profile of the sputum of these patients may be neutrophilic, eosinophilic or contain only a few inflammatory cells.
- Late onset asthma: seen in adults who present with asthma for the first time in adult life. These patients tend to be non-allergic.
- Asthma with fixed airflow limitation: is present in some patients who have had asthma for a long period of time and have undergone airway wall remodelling.
- Asthma with obesity: occurs in obese patients with prominent respiratory symptoms but little eosinophilic airway inflammation (Global Initiative for Asthma, 2017, p. 15).

Despite the continual work that is being undertaken to differentiate the phenotypes of asthma (Bhakta & Woodruff, 2011; Dean & Niven, 2017; George et al., 2015; Wenzel, 2012), what remains important in clinical practice is the physiological symptoms experienced by the

patient. The symptoms of acute asthma occur as a result of inflammation, hypersecretion of mucus, hyperinflation of the lungs and bronchoconstriction that are present during an exacerbation of the disease (Lugogo et al., 2010, pp. 891–892). These pathophysiological changes and the subsequent effect on the patient will be discussed below.

1.2.1 Inflammation

Type 2 T helper cells regulate allergic inflammation via the production of interleukin-3, interleukin-4, interleukin-5, interleukin-9, interleukin-10 and interleukin-13. A summary of the actions of each of these cytokines in relation to the pathogenesis of asthma is shown in Table 1.1. Cytokine production by Type 2 T helper cells begins the inflammatory process which is then exacerbated by the continuous secretion of cytokines, growth factors and inflammatory mediators as the first cells activate other cells and the process continues. Eosinophils (prominent cells in the airways of many asthmatics) are also activated by these cytokines to present antigens and secrete eosinophil peroxidase, leukotrienes, reactive oxygen species/reactive nitrogen species. Macrophages and neutrophils also contribute to the secretion of reactive oxygen species and reactive nitrogen species. At these increased levels, the reactive oxygen species and reactive nitrogen species cause epithelial damage, bronchoconstriction and mucous hypersecretion (Lugogo et al., 2010, p. 892).

Table 1.1 Effect of different cytokines in asthma

Cytokines	Effect in Asthma
Interleukin-3	Stimulates haematopoiesis
Interleukin-4	Involved in the synthesis of Immunoglobulin E and the recruitment of eosinophils to the airways
Interleukin-5	Regulates eosinophilic inflammation in asthma and subsequent airway hyperresponsiveness
Interleukin-9	Augments Type 2 T helper cell-driven inflammation, involved in mast cell release, Immunoglobulin E production and mucous hypersecretion
Interleukin-10	An anti-inflammatory cytokine that acts to inhibit inflammatory cytokine expression, chemokines, interleukin-5 and granulocyte-macrophage colony-stimulating factor production
Interleukin-13	Sufficient to induce acute asthma

Source/Note: Lugogo et al., 2010, p. 893

1.2.2 Airway Remodelling

Airway remodelling is one of the classic physiological changes in asthma. Remodelling is an alteration in the size, mass or number of tissue structural components that occur in

response to injury and/or inflammation. In asthma, the larger, more proximal airways are usually most affected (Jeffery, 2004, p. 176). Structural changes are associated with progressive loss of lung function. These structural changes increase airflow obstruction and airflow responsiveness and render the patient less responsive to therapy. The result of airway remodelling is a lung physiologically different to that of a person without asthma, as shown in Figure 1.8.

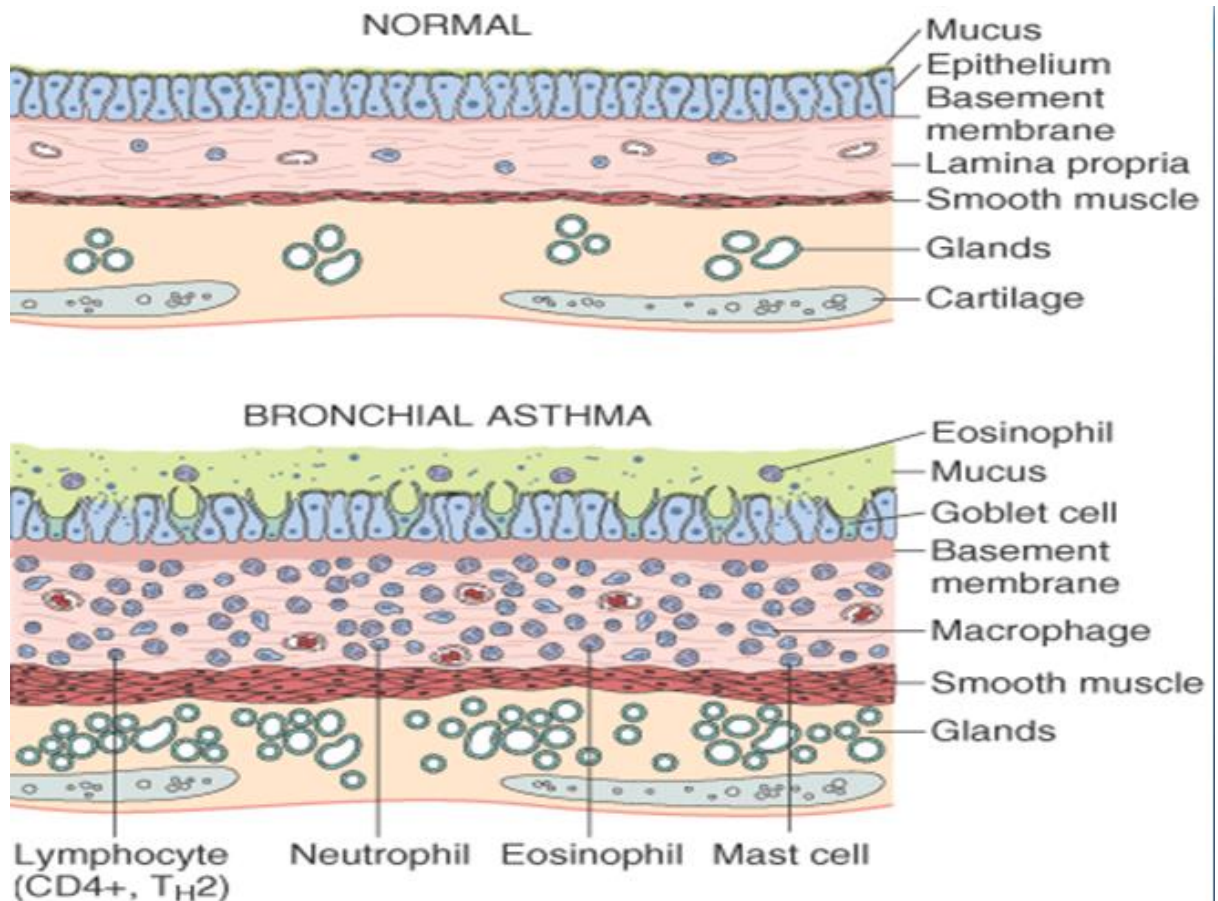


Figure 1.8 Airway remodelling in asthma

Source/Note: AirPhysio, 2015

The enlargement of bronchial smooth muscle mass is one of the most significant remodelling changes, although it remains unclear if it is the result of hyperplasia or hypertrophy (Jeffery, 2004, p. 181). In healthy subjects, bronchial smooth muscle encircles the airway in two opposing spirals. Thus, when muscle contracts, it not only constricts but also shortens the airway. In asthmatics, the same physiology is present, however, the significant increase in the mass of bronchial smooth muscle vastly increases the effect of this muscle contraction. Research has found that bronchial smooth muscle comprises approximately 12% of the airway wall in asthmatic subjects compared to about 5% in normal subjects (Bai & Knight,

2005; Fireman, 2003). Airway smooth muscle cells have also been shown to have a role in airway remodelling through the secretion of extracellular matrix proteins inducing a greater degree of cell proliferation (Lugogo et al., 2010, p. 896). It has been demonstrated that the infiltration of smooth airway muscle by mast cells affects the growth and function of smooth muscle.

The epithelium of the airways of patients with asthma is also affected by remodelling. This is thought to be the result of chronic injury and abhorrent repair which results in increased epithelial permeability. Disruption in the epithelial permeability allows allergens to enter the subepithelial space and incite an immune response. The resulting increase in growth factors then causes subepithelial fibrosis and remodelling. Beneath the epithelial basement membrane, the basal lamina in patients with asthma is thickened and hyalinised. There is also deposition of collagen, fibronectin and tenascin below the basement membrane. The airway structure is altered to incorporate more myofibroblasts which increase the extracellular matrix. This further contributes to stiffening and thickening of the airways (Lugogo et al., 2010).

Goblet cell hyperplasia is also a trait of asthmatic lungs and causes an increase in mucous production. In healthy subjects, mucous is an important component in the process of mucociliary clearance which removes foreign debris. During an acute asthma attack varying amounts of mucus can be found in the airway and contribute to airway blockage (Jeffery, 2004). The intraluminal contents in asthma are a mixture of mucus, inflammatory and epithelial cells, and exudate (Bai & Knight, 2005). This mucus can also cause thick plugs resulting in airway obstruction. When this obstruction occurs atelectasis of the lung parenchyma can develop distal to the obstructed lumen (Fireman, 2003).

Another feature of airway remodelling in asthma is bronchial neovascularisation which causes dilated and tortuous mucosal blood vessels. The airway microvasculature is more permeable causing mucosal oedema and subsequent airway narrowing (Bai & Knight, 2005; Jeffery, 2004). These vessels are also the source of inflammatory cells and of plasma derived mediators and cytokines. The cause of bronchial neovascularisation is thought to be due to an increase in vascular endothelial growth factor which may be caused by asthma (Lugogo et al., 2010).

1.2.3 Physiological Manifestations of Acute Asthma

The unique changes found in the lungs of patients with asthma cause a generally consistent set of physiological manifestations. Airway hyperresponsiveness is one such physiological manifestation and is defined as the tendency for the airways of asthmatic subjects to bronchoconstrict when exposed to various chemical and physical stimuli (McConnell & Holgate, 2000). Asthmatic airways of people with asthma have heightened responsiveness to the various stimuli that trigger little or no change in the airways of normal individuals (Fireman, 2003). Airway smooth muscle is the main effector of airway hyperresponsiveness (Ozier et al., 2011). During acute exacerbations of asthma bronchial smooth muscle contraction occurs quickly to narrow the airways in response to exposure to a variety of stimuli (National Heart, Lung, and Blood Institute, 2007).

Patients who have died from asthma commonly exhibit significant over-inflation of the lungs. This manifests as dramatic distension of the alveoli (Fireman, 2003). Hyperinflation in asthmatic patients is caused primarily by the limited ability for expiration. This is a result, firstly, of a decrease in expiratory driving forces due to abnormally low pulmonary elastic recoil and abnormally high outward recoil of the chest wall (Oddo, Feihl, Schaller, & Perret, 2006). Secondly, the constriction of airway smooth muscle severely reduces the size of airways (Oddo et al., 2006). As a consequence, the lung requires an extended time for expiration. If this extended period of expiration cannot occur, the air that was not expired becomes trapped resulting in increased positive end-expiratory pressure (PEEP), a phenomenon known as intrinsic PEEP (Oddo et al., 2006). Intrinsic PEEP resulting in hyperinflation increases as the amount of air trapped in the alveoli increases, as shown in Figure 1.9. Hyperinflation causes feelings of dyspnoea, increases dead space thus impacting on gas exchange, increases the work of breathing and in severe cases leads to haemodynamic compromise and barotrauma (MeDoff, 2008, p. 742).

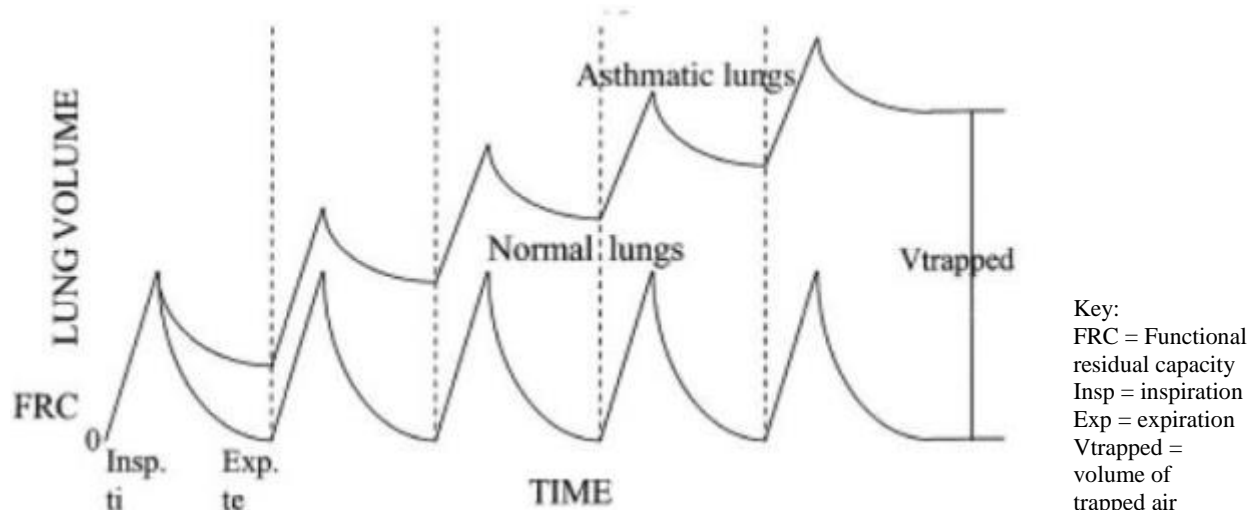


Figure 1.9 Dynamic hyperinflation in asthma

Source/Note: Levy, Kitch, & Fanta, 1998, p. 107

The haemodynamic compromise observed in acute asthma is primarily a result of changes in intrathoracic pressure due to pulmonary hyperinflation. Whilst hyperinflation causes increased pulmonary vascular resistance and right ventricular afterload, intrinsic PEEP also decreases venous return by elevating pleural pressures and right atrial pressures (Marini, 2011). The presence of PEEP can also decrease left ventricular afterload (Berlin, 2012). Hyperinflation may also stimulate autonomic reflexes thus causing bradycardia and vasodilation which can worsen cardiac output (Berlin, 2012). Furthermore, the pumping ability of the right side of the heart is compromised as it must work against the high pulmonary pressures exerted by increased PEEP and hyperinflation. Right ventricular pressure rises as the right ventricle is unable to work against high pulmonary vascular resistance. This, in turn, leads to a reduced perfusion gradient for right coronary blood flow possibly leading to right ventricular ischaemia (Berlin, 2012). As the right side of the heart begins to fail there is a subsequent decrease in output and failure of the left side of the heart. Fortunately, this cycle of progressive heart failure is primarily an issue in the inspiratory phase of the respiratory cycle as this is when pressures are at their highest. The prolonged expiratory phase of respiration observed in asthma is therefore somewhat protective as it allows the heart respite by providing low pressures (Berlin, 2012). Nevertheless, shock and cardiac failure have been documented in cases of severe hyperinflation (Berlin, 2012) and this puts increased importance on the requirement to decrease dynamic hyperinflation in asthmatic patients.

Patients experiencing an asthma attack will exhibit a range of symptoms including chest tightness, cough and shortness of breath (Asher et al., 2014, p. 14). Increased work of breathing results from increased airway resistance and reduced pulmonary compliance as a result of the high lung volumes. The dynamic hyperinflation seen in asthmatics causes a severe mechanical disadvantage as the diaphragm is flattened and there is a requirement for large inspiratory muscle effort which only produces a small change in inspiratory pressure. This can lead to insufficient alveolar ventilation and consequent hypercapnia. Ventilation-perfusion mismatch results in impaired gas exchange and increases the minute ventilation requirement, further adding to the work of breathing. If left untreated, these symptoms of an asthma exacerbation can increase in severity eventually leading to severe dyspnoea, acidosis and respiratory collapse (Grossman, 2014).

Asthma exacerbations that progress to requiring intensive care treatment have generally poorer outcomes than those that do not. Patients admitted to an ICU with asthma may require invasive ventilation. Invasive ventilation has been linked with a mortality rate of around 10% for patients with asthma (McDoff, 2008). This has been identified by Sydow (2003) to be due to a combination of the severity of their disease and the notorious difficulty of mechanically ventilating asthmatic patients. In particular, invasive ventilation risks inadvertent pulmonary hyperinflation and aggravation of bronchospasm (Tuxen & Naughton, 2009). Further complications of invasive ventilation in asthmatic patients include hypotension, circulatory arrest, pneumothoraces and acute necrotising myopathy (Tuxen & Naughton, 2009). There is a risk of the standard complications of invasive ventilation occurring which include, but are not limited to: nutritional deficiencies, pressure areas, post-traumatic stress, ventilator-associated pneumonia, barotrauma, peripheral and respiratory muscle weakness and sleep disturbance (Bersten, 2009). It has been reported that up to 46% of asthmatic patients requiring invasive mechanical ventilation experience at least one complication of this therapy (Smyth, 1998). Research has also demonstrated the high ICU mortality rate for patients with asthma (Afessa, Morales, & Cury, 2001). The economic impact of admitting patients with a preventable disease to the ICU is also significant when compared to admission to a general ward bed (Chuesakoolvanich, 2007). For these reasons, it is desirable to treat patients with NIV in preference to invasive ventilation where possible.

1.3 Noninvasive Ventilation

NIV is the delivery of assisted mechanical ventilation without the need for an invasive artificial airway. It allows for the provision of respiratory support to an alert, spontaneously breathing patient (Antonelli & Conti, 2000). NIV can be delivered to a patient using several different interfaces. It also allows different modes of delivery to be used according to individual patient needs. This enables maximum comfort and improves patient compliance. NIV delivered using an oronasal mask is shown in Figure 1.10. A mask is sized and fitted to the patient at one end and is connected to a machine capable of delivering positive pressure.



Figure 1.10 A patient receiving NIV via an oronasal mask
Source/Note: Soo Hoo, 2017

1.3.1 Historical Context of NIV

Throughout the 19th, 20th and 21st centuries, NIV machines have undergone a significant transformation to become the intuitive devices that are used in modern medicine. One of the first documented NIV devices was described by Scottish physician John Dalziel who invented a machine that could apply subatmospheric pressures to the body during respiratory depression. The device could be used rhythmically during inspiration to assist the person to breathe (Dalziel, 1838). Later, in 1864, the American tank respirator was patented by Alfred Jones who used a large syringe to develop negative pressure for a seated subject, shown in Figure 1.11. He used this machine to treat a variety of respiratory illnesses including asthma and bronchitis (Braun, 2015).

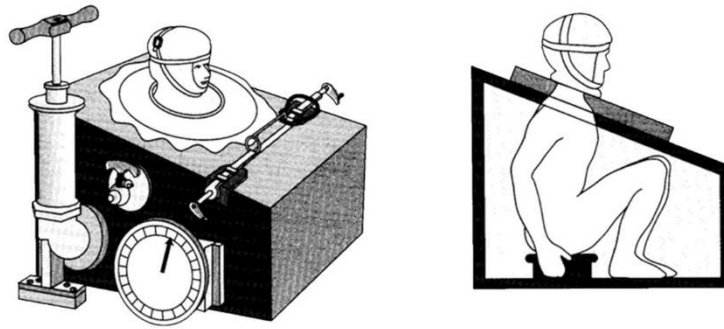


Figure 1.11 The American tank respirator patented by Alfred Jones in 1864
Source/Note: American Association for Respiratory Care, n.d.

In 1875, Eugene Joseph Woillez (France) made a device known as the ‘Spirophore’ and earned a silver medal at an exhibition of life-saving devices at Le Havre in 1876 (Hill, 1996). This device was quite similar to the American tank respirator but allowed the patient to lie on a bed and produced negative pressure using manually operated bellows.

In 1926, an American, Philip Drinker, was appointed by the Rockefeller Institute to develop improved methods of resuscitation. After initially experimenting on paralysed cats, the Drinker respirator was built which used electricity and a piston pump to generate pressure changes in the tank in which the patient was lying. In 1928, the first clinical trial on an eight-year-old girl with polio was deemed successful (although she died days later from pneumonia) (Hill, 1996). The Drinker respirator was modified by John Haven Emerson to a machine that cost less, was less bulky and had a head dome that could continue to ventilate the patient while the tank was opened for nursing care. The Emerson iron lung was used widely during the polio epidemic of the mid-20th century, as shown in Figure 1.12.



Figure 1.12 The widespread use of the Emerson iron lung during the mid-20C polio epidemic
Source/Note: Weeks, 2015

These inventions all used negative pressure for ventilation, classified as NIV due to their ability to provide respiratory assistance without the need for an invasive airway (Rabatin & Gay, 1999). Unfortunately, several issues with negative pressure ventilation began to surface such as their requirement for a large space, the inability to deliver PEEP, significant leakage causing patient cooling and a phenomenon known as ‘tank shock’ which was when patients would experience pooling of venous blood (Frederick, 1994). In response to this, the alternative of positive pressure NIV was examined.

The concept of positive pressure ventilation was not a new one and appears to have first been tried in 1870 by Chaussier, who used a bag and facemask to resuscitate neonates (Aboussouan & Ricaurte, 2010). In 1936, Poulton and Oxon (1936) described their preliminary plus pressure machine, which was a vacuum cleaner blower and mask used to increase alveolar pressure and counteract the increased intrapulmonary pressure in patients with heart failure, pulmonary oedema, Cheyne-Stokes breathing and asthma. The idea of positive pressure ventilation gained momentum when the first polio epidemics began and by

1938, research had been published on the use of NIV to treat acute pulmonary oedema (Barach, Martin, & Eckman, 1938). Throughout the next few decades, NIV continued to be used in practice (Ambiavagar, Sherwood Jones, & Roberts, 1967; Cournand, Motley, Werko, & Richards, 1947).

Although NIV was still being widely used in practice in the middle of the 20th century, by the 1960s, there were growing concerns that there was not enough published literature focused on its use to allow for the practice to continue. Additionally, in the early 1970s, it was recognised that respiratory physicians were treating hundreds of patients with intermittent positive pressure breathing, costing the United States healthcare system more than US\$400 million (McConnell, Maloney, & Buckberg, 1974). The American Thoracic Society sponsored a conference on the scientific basis of respiratory therapy to review this issue (Lourenco, 1974). Consequently, the lack of evidentiary support for the use of NIV in acute care was highlighted and its use subsequently decreased (Pierson, 2009).

NIV became popular again in the 1980s for chronic respiratory conditions. In 1981, Colin Sullivan invented a reversed vacuum machine that allowed for positive airway pressure to be delivered to patients with obstructive sleep apnoea (Antonescu-Turcu & Parthasarathy, 2010). Bilevel positive airway pressure (BiPAP) devices soon followed, initially for obstructive sleep apnoea and then for diverse neuromuscular diseases. The use of NIV quickly became the treatment of choice for patients with respiratory failure due to neuromuscular diseases, rib cage defects and the sequelae of tuberculosis. The use of NIV for obesity hypoventilation syndrome also became popular. In 1992, the company, Respironics, released a BiPAP ventilator. It rapidly became a popular new ventilatory mode in the field of NIV (Lobato & Alises, 2013). A five-year follow-up study of 276 patients, published in 1994, described the first series of NIV patients treated at home (Leger et al., 1994). The results showed a benefit in terms of survival for patients with neuromuscular diseases, kyphoscoliosis, sequelae of tuberculosis, COPD and bronchiectasis (Leger et al., 1994).

From 1990 to the present, clinical studies of the use of NIV for acute respiratory failure have become extensive (Rochweg et al., 2017). The delivery of NIV has vastly improved over the decades with increases in research and development of technology. NIV is now considered a standard of care for many forms of acute respiratory failure including acute exacerbations of COPD, pulmonary oedema, immunosuppression with lung infiltrates and

weaning patients with COPD from invasive ventilation (Rochweg et al., 2017). This popularity as a mode of respiratory support can be largely attributed to the ability of NIV to provide patients with similar types of support provided by invasive mechanical ventilation but without several of the adverse effects associated with invasively ventilating a patient.

Compared to invasive ventilation, NIV preserves normal physiological functions such as coughing, swallowing, feeding and speech and avoids the risk of laryngeal injury and respiratory tract infections (Aboussouan, 2010). Invasive ventilation necessitates sedation and analgesia. This exposes the patient to several complications associated with these medications and psychological distress for the patient and family associated with the patient's unconscious state (Antonelli & Conti, 2000). There is no requirement for patients treated with NIV to be sedated.

Unlike invasive ventilation, there is a potential for NIV to be delivered in areas other than critical care. Potential benefits associated with the ability to provide this treatment outside the ICU include early intervention, access to respiratory support for patients who would not otherwise be admitted to the ICU, provision of support and a less intimidating setting. The ability to provide NIV outside the ICU is dependent upon individual hospital resources including staff and physician training. Some studies have reported on the benefits of administering NIV on general wards, but this is yet to become a standard of practice due to the issues previously discussed (Rochweg et al., 2017).

As a standalone treatment, the technology now used to deliver NIV allows for optimal and comfortable treatment of patients with acute respiratory failure. Newer NIV machines track patients' breathing patterns to help ensure patient synchrony and comfort. They also provide auto-adaptive leak compensation, inspiratory triggering and expiratory cycling. The machines have user-friendly interfaces which allow clinicians to set parameters for both treatment and alarms.

1.3.2 Evidence for the Use of NIV for Asthma

NIV has been proposed to treat the pathophysiological changes associated with acute asthma. Empirical evidence does exist to suggest that NIV might be an appropriate treatment for acute asthma (Gupta, Nath, Agarwal, & Behera, 2010; Soma, Hino, Kida, & Kudoh, 2008; Soroksky, Stav, & Shpirer, 2003). This evidence, however, is not strong enough to provide irrefutable evidence due to the disparities in design, as will be discussed in Chapter 2. It

seems viable that the pathophysiological changes that occur during asthma such as narrowing of the airways should be able to be treated with a positive airway pressure such as that provided by NIV.

Several researchers have documented the benefit of continuous positive airway pressure (CPAP) for patients with stable or induced asthma (Busk et al., 2013; Lin et al., 1995; Slats, 2008). Mechanical strain during breathing has been recognised as an important modulator of airway responsiveness which is heightened in acute asthma (Busk et al., 2013). It is therefore feasible that influencing mechanical strain could affect the responsiveness of the airways during acute asthma. Slats (2008) demonstrated this effect using positive pressure inflation versus spontaneous inspiration and found positive pressure inflation of the lungs could significantly enhance deep inspiration-induced bronchodilation in patients with asthma. Busk et al. (2013) demonstrated the effect this had on airway reactivity and found that using CPAP in clinically stable asthmatics for a week significantly decreased airway reactivity. This was also tested in induced acute asthma and nasal CPAP was shown to enhance the bronchodilator effect of inhaled salbutamol, improve bronchial reactivity and reduce bronchial sensitivity (Lin et al., 1995). One other study has examined this effect in vivo on rabbits and found CPAP (6 cmH₂O) produced a persistent reduction of airway responsiveness, even in the presence of atopic airway inflammation (Xue, Yu, Gao, Gunst, & Tepper, 2011).

1.3.2.1 Intrinsic PEEP

Martin, Shore and Engel (1983) investigated the use of CPAP for histamine-induced bronchoconstriction. They found that CPAP significantly increased functional residual capacity, increased ventilation and decreased the work of breathing. This may be due to the stenting effect of CPAP on the airways and subsequent decrease in hyperinflation of the alveoli. This is shown in Figure 1.13 as the application of extrinsic PEEP, such as that from CPAP, decreases the inspiratory effort required when the small airways are constricted.

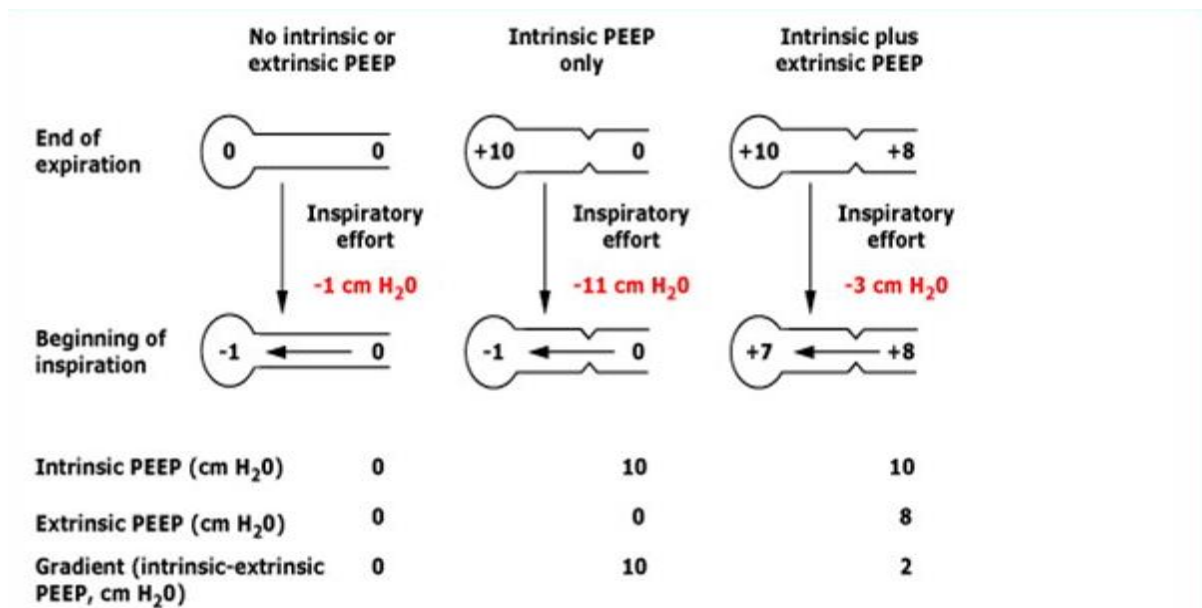


Figure 1.13 The effect of extrinsic PEEP on intrinsic PEEP

Source/Note: UpToDate, 2011

Intrinsic PEEP and subsequent hyperinflation have been shown to increase the work of breathing via several mechanisms. The patient must exert more pressure to overcome intrinsic PEEP and initiate a breath. Additionally, as the lungs hyperinflate, they become less compliant, further increasing the amount of work required by the patient to take a breath (Marini, 2011). The measurement of PEEP may underestimate the hyperinflation present in the lungs due to widespread airway closure at the end of inspiration (Smyth, 1998). The application of positive pressure during inspiration decreases the patient's work of breathing as it augments the respiratory effort. The use of extrinsic PEEP in asthmatic patients has long remained a controversy due to the belief that the application of extra PEEP can contribute to dynamic hyperinflation (MeDoff, 2008; Sydow, 2003). The benefit of extrinsic PEEP is that it may overcome intrinsic PEEP due to gas trapping and thus reduce the inspiratory threshold work of breathing. PEEP also increases respiratory system compliance and therefore reduces the elastic load to inspiration (Kallet & Diaz, 2009, p. 105). If tidal volume is increased with a shorter inspiratory time, then increased minute ventilation can occur without a proportional increase in dynamic inflation. Both of these improvements should lead to an improved ventilation/perfusion ratio (MeDoff, 2008, p. 744; Tuxen & Naughton, 2009, p. 406).

1.3.2.2 Work of Breathing

The dyspnoea associated with an acute asthma attack can provoke severe anxiety. The overall aim of providing respiratory assistance via NIV is to augment the patient's respiratory workload and decrease the patient's work of breathing. Severely dyspnoeic patients who tire risk complete respiratory collapse and subsequent cardiopulmonary arrest and therefore the augmentation of respiratory effort is aimed at reducing the respiratory workload to prolong individual respiratory effort long enough for first-line treatments to become effective. NIV reduces work of breathing via several mechanisms.

The application of inspiratory positive airway pressure is the main mechanism whereby the patient's work of breathing is reduced. This is due to the pressure support provided by the ventilator as the patient attempts inspiration. In simpler terms, the machine is pushing in air as the patient attempts to draw in a breath, thus the patient does not have to use as much energy as they would do working alone. Research conducted by Miro, Pinsky, and Rogers (2004) examined the components of NIV that decrease work of breathing. They found that inspiratory positive airway pressure had the most significant effect on work of breathing whilst expiratory positive airway pressure and CPAP also showed an effect. They also found that end-expiratory lung volumes were increased by inspiratory, expiratory and CPAP, but this was more significant in expiratory and CPAP (Miro et al., 2004).

1.3.2.3 Delivery of Oxygen

Hypoxaemia is a dangerous phenomenon seen in acute exacerbations of asthma. It is not a direct consequence of the physiological changes in asthma, but rather an indirect consequence of hyperinflation. During hyperinflation, the alveoli lose the ability to exchange carbon dioxide (CO₂)-rich air for oxygen-rich air and thus are unable to provide an oxygen supply to match the perfusion. The risk of hypoxaemia is further enhanced by the increased demand for oxygen as the workload of the respiratory muscles increases (Jungblut et al., 2014). NIV improves oxygenation primarily by treating the pathophysiologies that decrease the ability of the alveoli to expire air. Ventilators also allow clinicians to adjust the amount of oxygen in the inspired air, thus increasing the available amount of oxygen for ventilation (Jungblut et al., 2014).

1.3.2.4 Reduction of CO₂

High arterial CO₂ levels during severe asthma occur due to an inability to exhale CO₂-rich air from the lungs. High levels of CO₂ are therefore a reflection of poor gas exchange in an asthmatic (Jungblut et al., 2014). The treatment for reduction of CO₂ is restoring the patient's ability to exhale. This can be accomplished using NIV due to the stenting effect of positive pressure on the lungs as previously described. While this treatment takes effect, permissive hypercapnia may be safe. This is due to the relative safety of permissive hypercapnia as compared to the confirmed risk of barotrauma in patients ventilated with high pressures (Sydow, 2003).

NIV can play a role in treating many of the pathophysiological changes associated with an acute exacerbation of asthma including intrinsic PEEP, increased work of breathing, delivery of oxygen and removal of CO₂. It has also been shown to have an effect on airway reactivity in stable asthmatics. In addition to determining the potential for NIV to treat acute asthma, the context in which the treatment will be used is also an important factor in success. The healthcare context in which this study was undertaken will now be outlined.

1.4 Health Care and Nursing Context

1.4.1 Economic Structure

This research project was undertaken in Australia, a country with a complex healthcare system. Within the Australian system is a multifaceted web of public and private providers, settings, participants and supporting mechanisms (AIHW, 2016). The public health services are provided by all levels of government including local, state and federal but are managed by the state and territory governments. Private services are owned and operated by the private sector and include private hospitals, medical practices and pharmacies (AIHW, 2016). Figure 1.14 demonstrates the complexity of the healthcare system and its funding within Australia. The inner circle shows the share of expenditure between the three main sectors of the health system, the middle ring shows the responsibility for those services and the outer ring shows the funding source for each of the services.

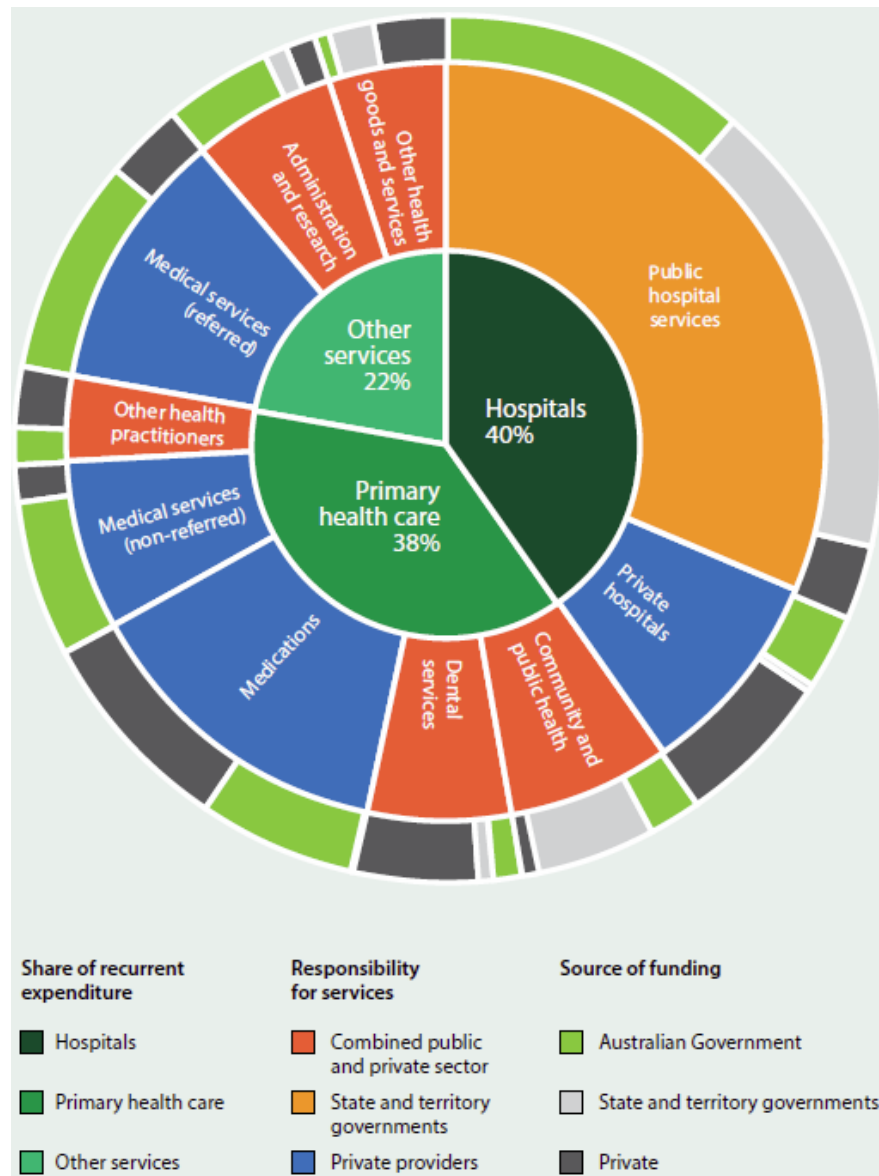


Figure 1.14 Funding within the Australian healthcare system
 Source/Note: AIHW, 2016, p. 28

1.4.2 Nursing Context and Effects of Rurality

Nurses and midwives are the largest group of healthcare professionals in the Australian health workforce (Francis & Mills, 2011). In 2017, 351,027 nurses registered with the Australian Health Practitioner Regulation Agency, 346,013 of whom were currently practising (Nursing and Midwifery Board of Australia, 2017). A large proportion of these nurses work within EDs, ICUs and HDUs. Within this capacity, these nurses are commonly required to care for patients being treated with NIV. In Australia, it has been estimated that 56% of all patients started on NIV outside of the ICU are transferred to the ICU (Schneider et al., 2011). It must also be considered that ICU and ED nurses are commonly members of

the medical emergency team who can also be responsible for commencing NIV on the wards (Khalid et al., 2014; Schneider et al., 2011).

The context in which nurses work has a significant impact on their ability to practise. This is particularly pertinent to the rural/regional areas of Australia such as the LHD in which this research was undertaken. Several issues have been identified that are unique to the practice of rural nurses including their lack of anonymity, fluidity of practice as a generalist, position within the community and professional/geographical isolation (Barber, 2007). These general issues result from and affect the recruitment of nurses to rural areas, the education they are provided and the scope of practice they must work within.

Recruitment and retention of nurses to regional and rural areas have long been identified as major challenges (Bushy, 2002). Previous research has shown that these are commonly caused by poor support and lack of opportunities for new graduate nurses in rural areas, poor management practices in rural health facilities, emotional demands of work, poor workplace communication and family responsibilities (Adams, 2016; Hegney, McCarthy, Rogers-Clark, & Gorman, 2002). Compounding the effect of low levels of recruitment and retention in rural nursing is a corresponding decreased number of doctors available in these areas (Bailey, Wharton, Holman, & D'Arcy, 2016; Bushy, 2002). This necessitates that the professional boundaries of these nurses may sometimes be blurred. Caveats are in place for rural emergency nurses in NSW, Australia, that extend their scope of practice to be inclusive of many tasks that are traditionally the role of the doctor, such as prescribing medications, suturing and ordering investigations (NSW Agency for Clinical Innovation, 2016).

As a result of their extended scope of practice, nurses working in rural and regional areas are often referred to as 'expert generalists' (Bushy, 2002; Hendrickx & Winters, 2017; Rosenthal, 2010). Extending the scope of practice of rural nurses is not a problem in itself but it has been recognised that these nurses have their responsibilities extended without a corresponding extension of their educational opportunities and resources (Francis & Mills, 2011). This is largely a result of the limited amount of infrastructure available for health care in isolated locations with low population density (Bushy, 2002). The consequence of this is that smaller hospitals generally have less equipment and less educational opportunities and these have been cited as major causes of stress and frustration in this workforce (Francis & Mills, 2011).

Issues with recruitment and retention, provision of education and a broad scope of practice therefore make rural nursing diverse and challenging (Godwin, 2012). It has been projected that as rural workforce numbers decline, the professional boundaries of nurses in these areas will become further blurred (Francis & Mills, 2011). It is likely that this will affect the issues already identified in rural nursing. Research on the unique experiences of these nurses is important for healthcare policy and integration of evidence into practice in this context (Kunaviktikul, 2014).

1.4.3 The Link Between Nursing and Clinical Outcomes

It has been extensively documented that the number of nurses and their education have a significant impact on outcomes for patients (Aiken et al., 2014; Cho et al., 2015; Needleman et al., 2011; Skekelle, 2013). This may be because they constitute the largest portion of the healthcare workforce and have 24-hour access to patients. They are the frontline staff who deliver treatments and interact with patients and their families. Nurses are particularly essential for patients receiving NIV as they are often responsible for the initiation, titration and discontinuation of the therapy (Sørensen, Frederiksen, Groefte, & Lomborg, 2013a). In addition to knowledge of physiology, pathophysiology and the practical application of NIV, nurses are also required to ‘care’ for patients which adds complexity to their role. This has been described as the dualism of care and cure (Sørensen et al., 2013a).

The context of the nursing workforce has been documented to affect clinical treatment and outcomes in a variety of ways. Previous research has shown the effect that nurse staffing has on the outcomes of patients. Nurse turnover is one contributor to the decrease in the nursing workforce and has significant effects on the productivity of organisations. Research has reported some of the most influential reasons for nurses to leave their current employment are a negative working atmosphere and job dissatisfaction due to disempowerment (Tummers, Groeneveld, & Lankhaar, 2013; Larrabee et al., 2003). It is in this way that, in addition to losing numbers with high turnover rates, organisations are losing expertise.

Lower numbers of nurses have been directly linked to increased adverse events and patients having longer lengths of stay in hospital (Needleman, Buerhaus, Mattke, Stewart, & Zelevinsky, 2001, p. 131). The effect of nursing numbers on the outcomes of patients has led to recommendations being made regarding nurse to patient ratios. This is also true for nurses looking after patients on NIV. Many guidelines stipulate that these patients should be

nursed 1:2 or 1:1. Unfortunately, the expansion of NIV services beyond critical care areas and staffing shortages within critical care areas sometimes do not allow for these ratios to be met which may compromise both the care of the patient and the experiences of the nurse.

Nurses' job satisfaction is viewed as integral to nurse retention (Hairr, Salisbury, Johannsson, & Redfern-Vance, 2014). It is therefore important that healthcare organisations understand the experiences of nurses and their daily activities and work to improve the context of nursing practice so that it is consistent with the needs of nurses. This cannot be achieved without examining the experiences of nurses. Similarly, policy-makers cannot effectively complete their roles unless they understand the complex needs of nurses and the unique interaction of nurses with their patients.

In addition to providing information for organisations, understanding the experiences of nurses is important for nurse educators. NIV is a potentially lifesaving treatment for many patients and requires skilled operators. Unfortunately, many staff report little or no training on the use of the machine before they are responsible for it, in practice. Obviously, this is dangerous for both the nurse and the patient. The effect of individual patients and context on the use of NIV also has consequences for nurses using the treatment. These are the daily intricacies of working in the frontline of health. People who write policy and develop education are often not those engaged in the frontline and so cannot account for these unique factors. This is further reason to explore and report the experiences of nurses so they can be used to guide policy and education.

1.4.4 The Integration of Evidence into Practice

The qualitative phase of this project is aimed at examining the experiences of nurses working in rural and regional areas who use NIV in practice. In addition to the effects the context of rurality might have on these nurses, it is also important to explore other issues that affect practice such as the use of evidence to guide clinical care. In health care there is currently a large evidence-practice gap (Leach & Tucker, 2017). The lag of practice behind published research is due to the many political, cultural and financial issues encompassing the healthcare system and its employees. It is important to understand the effect of context on experience and ways to enable nurses to utilise technology to treat patients.

It has previously been demonstrated that evidence alone is not enough to change practice. There are factors that inhibit and enable the use of new clinical technology, regardless of its

efficacy as a treatment. Grimshaw, Eccles, Lavis, Hill, and Squires (2012) have suggested that some of the barriers to promoting change in practice include knowledge, organisational structure, peer group and interactions between both professionals and consumers. Because these barriers are as unique as the different facilities in which health care is provided, it is important that researchers spend time understanding the experiences of healthcare staff and how they implement new technologies rather than concentrating on just the technologies themselves.

1.5 Research Questions and Significance

The purpose of this research project was to answer research questions arising from recognition of a need in the clinical environment, identification of the ongoing issues of treatment for acute exacerbations of asthma and gaps in the available literature. The background and context of the use of NIV in practice suggest that it is a useful treatment for many forms of acute respiratory failure and may be appropriate for use in asthma. Despite this, NIV has received little attention in relation to asthma, as will be discussed in Chapter 2. The effect of the context of the healthcare environment on clinicians' ability to use NIV has also not been investigated. The efficacy of NIV and the ability for it to be used in practice are equally important issues for health care, both for practice guidelines and healthcare policy. This project also investigated the efficacy of NIV in treating acute exacerbations of asthma in adults compared to standard medical therapy and explored the reasons why nurses may or may not utilise NIV in their practice. This was accomplished by answering the following questions:

1. How many patients with an acute exacerbation of asthma were treated with NIV and what type of NIV was used?
2. Which hospitals and specialty areas used NIV to treat acute asthma?
3. Does NIV provide better clinical outcomes for patients with an acute exacerbation of asthma compared to standard medical treatment?
4. What are the experiences of nursing staff using NIV?

Determining the efficacy of NIV in treating acute asthma is beneficial for patients. NIV for the treatment of other causes of acute respiratory failure has been shown to decrease hospital length of stay and mortality (Masip et al., 2005; Plant, Owen, & Elliott, 2000). NIV is particularly desirable in comparison to the alternative of invasive ventilation which is a

difficult treatment for patients with asthma and has a high mortality rate and requirement for sedation among other possible complications (MeDoff, 2008; Sydow, 2003).

Clinicians will benefit from this research as it will help to guide their practice and will also help in aligning practice guidelines with the needs of clinicians. This project also aims to give rural and regional nurses a voice. Nurses in these areas are often understaffed, under-resourced and isolated (Fitzgerald & Townsend, 2012; Hegney & McCarthy, 2000; Hegney, Tuckett, Parker, & Robert, 2010). This project aims to capture some of their unique experiences in acting as generalists and barriers they face in implementing best practice. Respiratory and critical care researchers will benefit from a broadened scope of knowledge and new directions for future research.

1.6 Overview of Methodology

This research project will be underpinned by the philosophical assumptions of pragmatism and is designed as a mixed methods study. Pragmatism is a paradigm created with the purpose of finding a commonsense approach to philosophical dualisms based on how well they work in solving problems (Johnson & Onwuegbuzie, 2004). Knowledge is viewed as being constructed and based on the reality of the world we experience and live in while theories are viewed instrumentally by how well they currently work (Johnson & Onwuegbuzie, 2004). The pragmatic method states that the current meaning or instrumental or provisional truth value of an expression is to be determined by the experiences or practical consequences of belief in or the expression in the world (Murphy, 1990). What this infers is that pragmatism is outcome oriented.

Mixed methods combine the use of qualitative and quantitative research in an attempt to capitalise on strengths and avoid the weaknesses of the two prominent research methods (Creswell & Plano Clark, 2017). Mixed methods have been defined as “The class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts, or language in a single study” (Johnson & Onwuegbuzie, 2004, p. 17). Utilising pragmatism, mixed methods are able to move from the inductive and deductive constraints of quantitative and qualitative design respectively and instead, design research that incorporates induction, deduction and abduction (Johnson & Onwuegbuzie, 2004). Abduction allows the researcher to move to and from induction and deduction, first converting observations into theories and then assessing those theories through action

(Morgan, 2007). In this way, pragmatism allows for abductive-intersubjective-transferable aspects of research to be emphasised (Morgan, 2007). By avoiding the traditional limitations of research, mixed methods allow for researchers to be creative and follow their questions in the direction that will best provide an answer (Johnson & Onwuegbuzie, 2004).

The specific type of mixed methods that will be used in this study is a sequential explanatory design. This design has been described in the literature by Creswell and Plano Clark (2017) and Ivankova, Creswell, and Stick (2006). The basic premise is that the research project is conducted in two distinct phases using both quantitative and qualitative methodologies which are integrated at specified points in the project (Ivankova et al., 2006). The rationale for this approach is that quantitative data and subsequent analysis provide a general understanding of the research problem (Ivankova et al., 2006). In this instance, the collection of biometric and descriptive data will allow examination of the efficacy of NIV to treat acute asthma. This will allow for investigation of the first three research questions focused on the efficacy and location of NIV treatment for acute asthma.

Following quantitative data collection and analysis, the qualitative phase of the project will be undertaken. The qualitative data will provide another dimension to this research project and enrich the quantitative data by exploring the human element. There is little advantage gained by proving a treatment works if the context in which the treatment is used and clinicians' ability to use it are not understood. The advantages of using a sequential explanatory design are that it is straightforward and provides opportunities for the exploration of the quantitative results in more detail. This will be especially useful if unexpected results arise (Ivankova et al., 2006). A full explanation of the philosophical assumptions and methodology of this project can be found in Chapters 3 and 4.

1.7 Organisation of Thesis

This thesis is organised into nine chapters, each detailing a portion of the research project undertaken. Chapter 2 will follow on from the introduction provided in Chapter 1 by giving a critique and discussion of the current available literature addressing the issues underpinning this research project including the use of NIV for the treatment of asthma and the effect of context on the ability of clinicians to use specific treatments. Chapter 3 will then focus on the philosophical assumptions of pragmatism that guided the design of this project. The methods used for data collection and analysis in both the quantitative and qualitative

phases of this project will be discussed in Chapter 4. Due to unique results provided by the two distinct research phases and the requirement for them to be integrated, there are three separate results chapters. Chapter 5 focuses on the quantitative results alone, Chapter 6 explores the qualitative data and Chapter 7 is an integration of both sets of results to examine crossover, complementary and unique material. Following the results, a discussion is presented in Chapter 8. The thesis concludes with recommendations, reflection and conclusions in Chapter 9.

1.8 Chapter Summary

This chapter has introduced asthma as an illness and its burden on society in regard to death, disability and economics. The pathophysiology of asthma has been discussed as well as the effects of an acute exacerbation of this respiratory illness. NIV has been proposed as a feasible treatment for acute asthma and the mechanism of action of NIV examined. Chapter 1 has also provided a brief introduction to the context of the healthcare and nursing environment in which this research project took place. Finally, a brief explanation of the design of the research project has been provided. Subsequent chapters in this thesis have been outlined to enable ease of readership. Chapter 2 will follow with a rigorous review of the available literature that has examined the use of NIV for the treatment of acute asthma and the contextual effect of the healthcare environment on nursing practice.

Chapter 2: Literature Review

2.1 Introduction

This chapter will detail literature reviews undertaken to explore the current evidence regarding the use of NIV for asthma and the experiences of nurses using NIV in practice. Due to the mixed methods design of this project, a two-phase literature review was undertaken. The first phase examined the quantitative evidence for the use of NIV for acute exacerbations of asthma in adults. The second explored the clinicians' experiences using NIV in acute care. A summation is provided at the end of the chapter to discuss where the two separate phases interlink.

2.2 Phase 1 Literature Review: The Use of NIV for the Treatment of Acute Exacerbations of Asthma in Adults

There is currently no consensus in international guidelines for the use of NIV for asthma (Chawla et al., 2013; Keenan et al., 2011; Sanchez, Smith, Piper, & Rolls, 2014). Despite this, clinicians have adopted this treatment in practice (Scala, 2016). This review aimed to determine whether NIV is a safe treatment for these patients and whether it provides better clinical outcomes compared to standard medical therapy alone. The focus of the review is adult patients who present to hospital with moderate to severe asthma. Approximately 5–10% of asthmatic patients experience a severe asthma attack each year and, of those who are admitted to hospital, 10% require ICU admission (Scala, 2010). In-hospital mortality rates for patients with severe asthma who require ICU admission have been reported to be between 3.2% and 9.8%, with higher mortality rates seen in patients who require invasive ventilation (Pendergraft et al., 2004; Stow et al., 2007). For this reason, NIV may play an important role in decreasing the requirement for invasive ventilation and associated mortality.

2.2.1 Aim

The aim of this systematic review was to examine the current available evidence for the use of NIV as a treatment for acute exacerbations of asthma in adults. The clinical outcomes of interest are mortality, ICU and hospital length of stay, and dyspnoea scores.

2.2.2 Method and Data Evaluation

Database searches were conducted using EBSCOhost, MEDLINE and PubMed. Search terms used were combinations of ‘noninvasive ventilation’, ‘BiPAP’, ‘CPAP’, ‘wheez*’ and ‘asthma’. Inclusion criteria were studies that focused on patients with asthma, the treatment of NIV, those that were published in English, and those with research designs. Studies were excluded if they focused on patients aged younger than 18 years. There was no limit set on date of publication as there has been limited research conducted on this topic. Studies were initially shortlisted for inclusion based on article title. Abstracts were then examined against the inclusion and exclusion criteria and relevant papers shortlisted again. At the same time as each full text was evaluated, a review of the reference list was undertaken to identify any omitted relevant research. The studies that met the inclusion criteria were individually examined and rated according to the level of evidence (Table 2.1) and quality appraisal tools (Dreyer, Velentgas, Westrich, & Dubois, 2014; National Health and Medical Research Council [NHMRC], 1999).

Table 2.1 Hierarchy of evidence for interventional studies

Level	Intervention
I	A systematic review of level II studies
II	A randomised controlled trial
III-1	A pseudo-randomised controlled trial
III-2	A comparative study with concurrent controls: <ul style="list-style-type: none">• Non-randomised experimental trial• Cohort study• Case control study• Interrupted time series with a control group
III-3	A comparative study without concurrent controls: <ul style="list-style-type: none">• Historical control study• Two or more single arm studies• Interrupted time series without a parallel control group
IV	Case series with either post-test or pre-test/post-test outcomes

Source/Note: NHMRC, 1999, p. 56

The quality appraisal tool used to evaluate the randomised controlled trials (RCT) in this review was developed by the NHMRC and was recommended by the Council (NHMRC, 2000). Broadly, the evidence provided by the RCTs is rated as Level II according to the hierarchy of interventional studies – see Table 2.1. The initial intention of this review was to conduct a meta-analysis of study results; however, this was unable to be accomplished due to differing study endpoints and variable hypotheses used in the RCTs and subsequently,

a systematic review was conducted (Onwuegbuzie & Frels, 2016). Observational studies were therefore also included and evaluated according to the GRACE Checklist which had previously been tested for validity (Dreyer et al., 2014).

2.2.3 Results

The literature search returned a possible 490 matches which were shortlisted according to title and then again by abstract content before being reviewed in full. Figure 2.1 shows the selection process that was undertaken as per the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) reporting flow chart (Liberati et al., 2009).

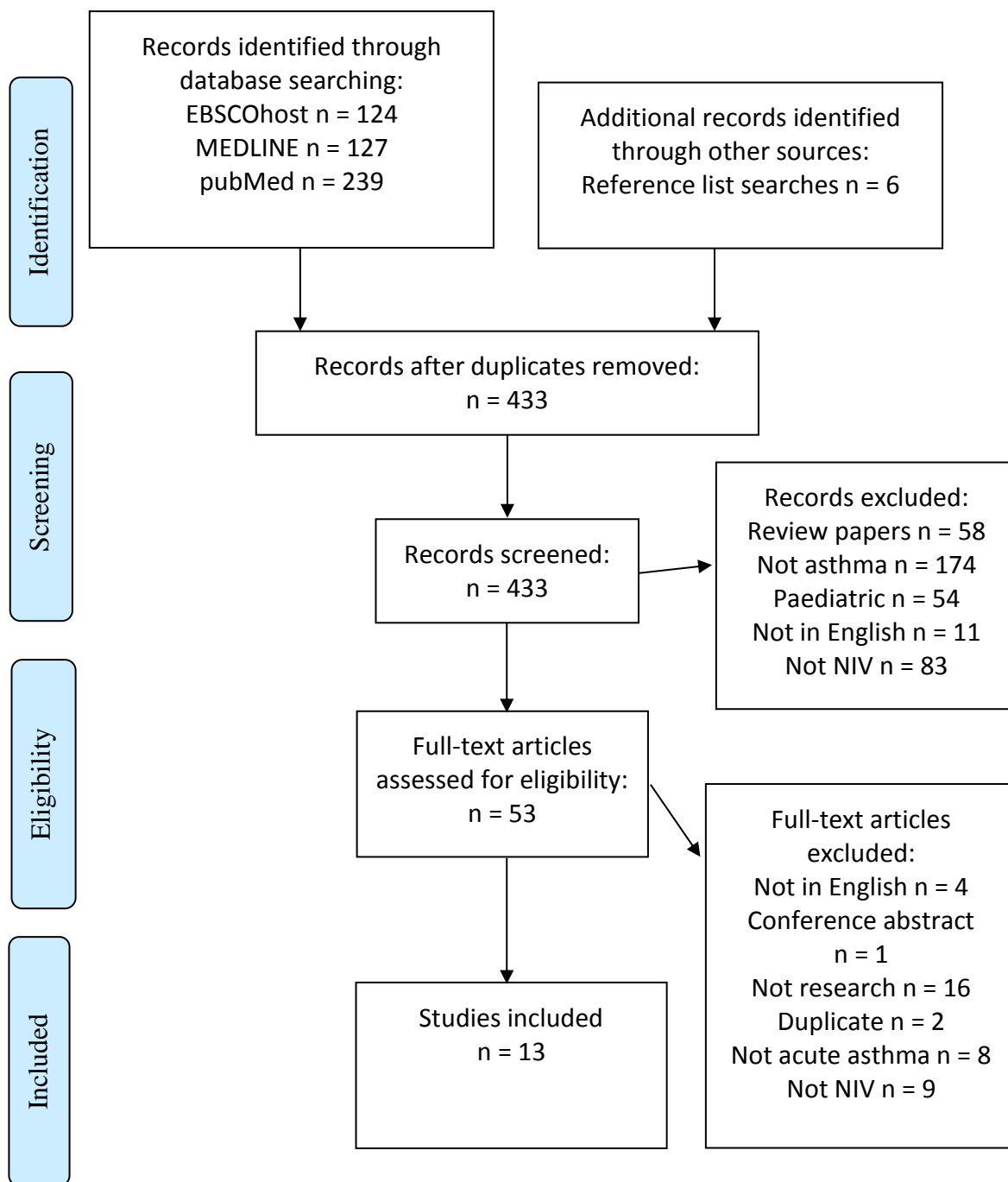


Figure 2.1 PRISMA flow chart of quantitative studies – Phase 1 literature review
 Source/Note: Liberati et al., 2009

Thirteen articles were included in the review of which seven were RCTs; two were retrospective cohort studies; two were interrupted time series without a parallel control group; one was a five-year, case control study; and one was a meta-analysis of RCTs. Methodological characteristics and findings of the individual studies are shown in Table 2.2 in conjunction with the evidence levels assigned to each study.

Table 2.2 Methodological characteristics, evidence level and findings of studies – Phase 1

Author/Date	Design/Sample	Treatment	Findings	Evidence level
Lim et al., 2012	Meta-analysis Five RCTs	Four studies used BiPAP v. control One study used CPAP v. control	The results did not show a clear benefit for NIV when mortality rate and tracheal intubation were meta-analysed from two studies Further meta-analysis was not possible due to differing outcome measures	Level I
Galindo-Filho et al., 2013	RCT Adults with moderate to severe asthma attack	Control group n=11 v. nebuliser group n=10 (NIV and nebulisation)	Respiratory rate was reduced and tidal volume increased in the experimental group Pulmonary function was improved in the experimental group No difference was observed in radio-aerosol deposition index or pulmonary clearance	Level II
Gupta et al., 2010	RCT Adults with severe acute asthma	Control group n=25 (standard medical therapy: oxygen, albuterol, ipratropium and hydrocortisone) v. NIV group n=28 (standard medical therapy and BiPAP)	The NIV group had a non-significant improvement in forced expiratory volume in one second The mean dose of inhaled bronchodilator was less in the NIV group There was a trend towards shorter ICU and hospital length of stay There was a trend towards improvement in accessory muscle use	Level II
Brandão et al., 2009	RCT Adult patients with severe asthma	Control group n=12 (jet nebuliser: fenoterol bromidrate, ipratropium, normal saline) v. NIV group 1 n=12 (jet nebuliser + BiPAP 15/5) v. NIV group 2 n=12 (jet nebuliser + BiPAP 15/10)	NIV group 1 showed an increase in peak expiratory flow when compared before and after treatment NIV group 2 showed an increase in peak expiratory flow, forced vital capacity and forced expiratory volume over one second when compared before and after treatment	Level II

Author/Date	Design/Sample	Treatment	Findings	Evidence level
Soma et al., 2008	RCT Adult patients with mild to moderate asthma	Control group n=14 (5 mg/kg of intravenous hydrocortisone) v. NIV group 1 n=14 (BiPAP 6/4 and 5 mg/kg of intravenous hydrocortisone) v. NIV group 2 n=16 (BiPAP 8/6 and 5 mg/kg of intravenous hydrocortisone)	Mean forced expiratory volume in one second improved in NIV group 2 compared to control group Both NIV groups had an improvement in Borg dyspnoea scale scores	Level II
Soroksky et al., 2003	RCT Patients with severe asthma attack	Control group n=15 (medical management: salbutamol, ipratropium and intravenous corticosteroids and sham NIV) v. experimental group n=15 (medical management and BiPAP – initially 8/3 and titrated up to 15/5 according to patient requirement and comfort)	The NIV group showed improved lung function tests compared to the control group The NIV group had more patients reach the predetermined study endpoints There was a trend towards less requirement for hospitalisation in the NIV group that did not reach statistical significance	Level II
Pollack, Fleisch, & Dowsey, 1995	RCT Afebrile, wheezing patients between 18 and 40 years of age who presented to hospital with acute bronchospasm and a history of asthma	Control group n=40 (two doses of nebulised salbutamol) v. experimental group n=60 (two doses of salbutamol via BiPAP circuit)	Increase in peak expiratory flow rate was greater in the experimental group No difference was observed in rates of admission to hospital No difference was observed in pulse oximetry, pulse rate or respiratory rate between the two groups	Level II
Pallin, Hew, & Naughton, 2015	Five-year case control	30 patients treated with NIV, 17 patients treated with invasive ventilation and 90 controls	Length of hospital stay in the NIV group was similar to the invasive ventilation group and longer than in the control group	Level III-2

Author/Date	Design/Sample	Treatment	Findings	Evidence level
			Mortality was zero in the NIV and control groups and 41% in the invasive ventilation group (not statistically tested)	
Nanchal et al., 2013	Interrupted time series without a parallel control group Data from 488,575 patients discharged after an admission with asthma exacerbation	Compared the rates of in-hospital mechanical ventilation and mortality from 2000 to those in 2008	There was an increase in the use of mechanical ventilation There was a shift from invasive mechanical ventilation to NIV Hospital stay and mortality were unchanged	Level III-3
Murase et al., 2010	Interrupted time series without a parallel control group Data from 107 events	Compared patients admitted between November 1999 and October 2003 (pre-NIV introduction) to patients admitted between November 2004 and October 2008 (post-NIV introduction)	The rate of invasive ventilation decreased in the post-NIV period NIV was started earlier than invasive ventilation Hospital length of stay was shorter in the post-NIV introduction period No deaths occurred as a consequence of asthma attacks in the data collection periods	Level III-3
Fernandez, Villagra, Blanch, & Fernandez, 2001	Retrospective cohort study	11 patients who received invasive mechanical ventilation were compared to 22 patients who received NIV	No differences were found in median length of ICU stay No differences were found in median length of hospital stay No differences were found in mortality The patients who received invasive ventilation had lower pH on admission	Level III-2

Author/Date	Design/Sample	Treatment	Findings	Evidence level
Meduri, Cook, Turner, Cohen, & Leeper, 1996	Retrospective cohort study	Described outcomes for 17 events of exacerbation of asthma and hypercarbia receiving NIV and compared them to the outcomes of four events of exacerbation of asthma and hypercarbia receiving invasive ventilation	From baseline to two hours a significant reduction in pCO ₂ and pH were observed in the NIV group Results were similar when response to NIV and invasive ventilation were compared over time NIV caused no complications Two patients on NIV required sedation compared to all patients receiving invasive ventilation (three of whom were also paralysed) (not statistically tested)	Level III-2
Holley, Morrissey, Seaberg, Afessa, & Wears, 2001	RCT Patients remaining in status asthmaticus after initial medical therapy	19 patients in the treatment group received standard medical therapy and BiPAP (IPAP 10, EPAP 5 initially, then titrated to comfort) 16 patients in the control group received standard medical therapy including oxygen, salbutamol and methylprednisolone	The treatment group had lower endotracheal intubation rates, lower median hospital stay and lower median hospital charges No significant difference between groups was observed in regards to vital signs, peak expiratory flow rates or pulse oximetry values	No level designated RCT terminated early due to recruitment bias

Note: Reports of differences are those that were statistically significant unless stated otherwise

There were seven RCTs found in the literature that examined the use of NIV compared to standard medical therapy as a treatment for acute asthma. All the studies were conducted in EDs in single centres excluding the study by Gupta et al. (2010) which was conducted in a respiratory ICU. There were several issues noted in the design and reporting techniques used in these studies.

Regarding treatment blinding, only Soroksky et al. (2003) were able to attain blinding of patients and physicians to the treatment group, although outcome assessors were not blinded. The ability of an imitation NIV device to accomplish true blinding is contentious. Researchers have reported an inability to blind participants because of the difficulty of using an imitation device to represent true NIV treatment (Gupta et al., 2010). Soroksky et al. (2003) reported they used an imitation device that had four holes in the circuit tubing to generate maximum air leak and, subsequently, sub therapeutic pressures. The ability of this imitation device to achieve its desired effect was largely dependent on the patient having no knowledge of what NIV treatment should look/feel like. Patients who were aware of NIV treatment would know that it requires positive pressure and may have been suspicious of the holes in the connective tubing. With the growing rate of NIV use in the past decade, many people have directly or indirectly been exposed to this treatment previously (McNeill & Glossop, 2011).

Randomisation of treatment assignment was claimed by some researchers without blinding of the investigator or reporting the blinding technique (Brandão et al., 2009; Soma et al., 2008; Soroksky et al., 2003). Others claimed blind randomisation but did not report method of randomisation used (Pollack et al., 1995). Only three of the RCTs (Galindo-Filho et al., 2013; Gupta et al., 2010; Holley et al., 2001) met the criteria for reporting correct randomisation sequences. Incorrect randomisation techniques affect the internal validity of studies as they may affect the comparability of the groups and cause allocation bias (Landorf, 2017). Table 2.3 outlines the appraisal of the quality of the RCTs.

Table 2.3 Appraisal of the quality of the RCTs

Author/Year	Method of treatment assignment	Control of selection bias after treatment assignment	Blinding to treatment
Galindo-Filho et al., 2013	Correct, blinded randomisation method described OR randomised, double blind method stated AND group similarity documented	Analysis by treatment received AND no mention of withdrawals OR more than 15% withdrawals/ loss-to-follow-up/post-randomisation exclusions	Blinding not done
Gupta et al., 2010	Correct, blinded randomisation method described OR randomised, double blind method stated AND group similarity documented	Intention-to-treat analysis AND full follow-up	Blinding not done
Brandão et al., 2009	Randomisation claimed but not described and investigator not blinded	Analysis by treatment received only OR no mention of withdrawals	Blinding not done
Soma et al., 2008	Randomisation claimed but not described and investigator not blinded	Analysis by treatment received only OR no mention of withdrawals	Blinding not done
Soroksky et al., 2003	Randomisation claimed but not described and investigator not blinded	Intention to treat analysis AND < 15% loss to follow-up	Blinding of outcome assessor OR patient and caregiver
Holley et al., 2001	Correct, blinded randomisation method described OR randomised, double blind method stated AND group similarity documented	Analysis by treatment received AND no mention of withdrawals OR more than 15% withdrawals/loss to follow-up/post-randomisation exclusions	Blinding not done
Pollack et al., 1995	Blinding or randomisation stated but method not described OR suspect technique	Analysis by treatment received only OR no mention of withdrawals	Blinding not done

Source/Note: NHMRC, 1999

Two of the studies reported statistical analysis based on intention-to-treat data (Gupta et al., 2010; Soroksky et al., 2003). Consequently, data from patients who did not complete the treatment protocol would have been omitted from the final analysis of all other RCTs which may have confounded results and thus the comparability of the treatment and control groups. There was also an issue with enrolment bias reported by Holley et al. (2001) who had to prematurely terminate their trial due to physician bias affecting recruitment. They used physician discretion to determine which patients met the inclusion/exclusion criteria and thus were eligible for randomisation and inclusion in the study. There were 25 patients enrolled in the trial every month for the first year which decreased to 0.4 patients per month for the final 22.5 months (Holley et al., 2001). Two explanations were offered to account for the significant decrease in enrolment numbers. The first explanation was a decrease in new (novel) admissions as patients who re-presented after an initial admission were excluded from the study. The authors also suggested physicians were unwilling to enrol participants in the study as they believed it was unethical to withhold BiPAP treatment from the control arm of the study (Holley et al., 2001).

Five retrospective studies were found that examined the use of NIV for acute asthma. Retrospective studies form an important component of the current literature on this topic as they enable researchers to obtain large sample numbers and do not involve the ethical issue of withholding treatment that is required for RCTs, as was reported by Holley et al. (2001). The disadvantage of using retrospective designs in this instance is that the studies were conducted over significant periods of time to allow for larger sample sizes thus making them vulnerable to confounding caused by the fast-paced change in treatment practices and lifestyle over time. This was remarked on by Murase et al. (2010) who found that when collecting more recent data, a greater number of patients were regularly taking inhaled corticosteroids and long acting β_2 -agonists.

The retrospective studies included cohort designs, interrupted time series without parallel control groups and case control designs. These studies inherently posed issues such as comparability of the exposed and unexposed groups (Graham, 2017). This was reported by Pallin et al. (2015) who described the two compared groups as different at baseline (the NIV group had higher blood pressure, increased work of breathing and greater acid-base abnormality than the control group). Similar to the RCTs, the retrospective studies utilised vastly different study endpoints. The use of variable study endpoints affects the ability to

make generalisations based on multiple findings (Onwuegbuzie & Frels, 2016). An appraisal of the quality of the observational studies according to the GRACE Checklist can be found in Table 2.4.

Table 2.4 Appraisal of the quality of the observational studies

Components	Studies*				
	1	2	3	4	5
1) Were treatment and/or important details of treatment exposure adequately recorded for the study purpose in the data source(s)?	✓	×	×	✓	✓
2) Were the primary outcomes adequately recorded for the study purpose (e.g., available in sufficient detail through data source(s))?	✓	✓	✓	✓	✓
3) Was the primary clinical outcome(s) measured objectively rather than subject to clinical judgment (e.g., opinion about whether the patient’s condition has improved)?	✓	✓	✓	✓	✓
4) Were primary outcomes validated, adjudicated, or otherwise known to be valid in a similar population?	×	✓	×	×	×
5) Was the primary outcome(s) measured or identified in an equivalent manner between the treatment/intervention group and the comparison group(s)?	✓	✓	✓	✓	×
6) Were important covariates that may be known confounders or effect modifiers available and recorded?	✓	✓	×	×	✓
Methods	1	2	3	4	5
1) Was the study (or analysis) population restricted to new initiators of treatment or those starting a new course of treatment?	×	×	×	×	×
2) If one or more comparison groups were used, were they concurrent comparators? If not, did the authors justify the use of historical comparisons group(s)?	✓	✓	✓	✓	×
3) Were important covariates, confounding and effect modifying variables taken into account in the design and/or analysis?	×	✓	×	×	×
4) Is the classification of exposed and unexposed person-time free of “immortal time bias”?	✓	✓	✓	✓	✓
5) Were any meaningful analyses conducted to test key assumptions on which primary results are based?	×	×	×	×	×
*1) Pallin et al., 2015; 2) Nanchal et al., 2013; 3) Murase et al., 2010; 4) Fernandez et al., 2001; 5) Meduri et al., 1996					

Source/Note: Dreyer et al., 2014, p. 304

All the studies found either no difference between the control groups and intervention groups or improvements in the intervention groups (significant and non-significant). It is notable that none of the studies found negative outcomes from the application of NIV.

2.2.4 Discussion of the use of NIV to treat acute exacerbations of asthma

This systematic review suggests that the use of NIV for patients with acute exacerbations of asthma is feasible and safe. It is difficult, however, to draw definitive conclusions regarding the effect of NIV on mortality or length of stay for patients with asthma based on the current body of evidence.

Prior to this review being conducted, several researchers had documented the benefit of CPAP for patients with stable or induced asthma (Busk et al., 2013; Lin et al., 1995; Slats, 2008). Mechanical strain during breathing has been recognised as an important modulator of airway responsiveness which is heightened in acute asthma (Busk et al., 2013). It is therefore feasible that influencing mechanical strain could affect the responsiveness of the airways during acute asthma. Slats (2008) demonstrated this effect using positive-pressure inflation versus spontaneous inspiration and found positive-pressure inflation of the lungs could significantly enhance deep inspiration-induced bronchodilation in patients with asthma. Busk et al. (2013) demonstrated the effect this had on airway reactivity and found using CPAP in clinically stable asthmatics for a week significantly decreased airway reactivity. This was also tested in induced acute asthma and nasal CPAP was shown to enhance the bronchodilator effect of inhaled salbutamol, improve bronchial reactivity and reduce bronchial sensitivity (Lin et al., 1995). One other study examined this effect in vivo on rabbits and found CPAP (6 cmH₂O) produced a persistent reduction of airway responsiveness even in the presence of atopic airway inflammation (Xue, 2011). The results of these studies demonstrate the potential benefits of using NIV for acute asthma, but this must translate into outcomes that are important for patients and the healthcare system such as mortality, patient comfort and length of stay.

Except for one study by Gupta et al. (2010), all RCTs included in this review were conducted within the ED. Conducting this research in EDs was appropriate as it is the first point of contact for patients presenting to hospital and is often the environment in which NIV is commenced. The issue, however, is that six of the studies (i.e. Brandão et al., 2009; Galindo-Filho et al., 2013; Gupta et al., 2010; Pollack et al., 1995; Soma et al., 2008; Soroksky et al.,

2003) collected biometric data for four or less hours. This limits the ability of the research to show moderate and long term effects of NIV treatment for asthma. Additionally, the studies that collected data for less than four hours may not have been able to show the extent of the short-term effect of NIV. Some researchers have suggested the full therapeutic benefit of NIV may not be reached for up to four hours after application (Bott et al., 1993; Plant et al., 2000). It should also be noted that, as previously discussed, NIV is commonly used in the ICU and therefore extending research from ED to the ICU is of benefit to a wider critical care audience who often use this treatment.

This review was unable to show a clear benefit of using NIV compared to standard medical therapy for mortality rates in this population. Studies in this review found no mortality in the patients with asthma treated with NIV (Murase et al., 2010; Pallin et al., 2015). Mortality rates in admitted patients with asthma are difficult to calculate as in-hospital mortality is low in this patient group (Cabrini et al., 2015). Alves et al. (2014) found a mortality rate of 1.5% for patients in their study who were hospitalised for asthma, which increased to 2.5% when the patient deteriorated to a point where they required treatment with NIV. It is likely that this effect was the result of comparing patients who were more unwell and requiring NIV to those who only required standard medical therapy. This is reflected in a study that compared invasive mechanical ventilation to NIV and found over time 60-day mortality rates for patients who received first-line NIV decreased from 27% to 9% whereas the mortality rate for first-line invasive ventilation was stable at around 30% (National Health Performance Authority, 2013b). It is also important to consider that the timeliness of intervention influences mortality as well as the treatment itself. Early intervention with NIV in the ED has been shown to reduce rates of ICU admission and mortality (Tomii et al., 2009).

In regards to hospital and ICU length of stay the studies included in this review had conflicting results. One of the interrupted time series studies found a reduction in hospital length of stay after NIV was introduced into their facility (Murase et al., 2010), but the other time series study found no difference in hospital length of stay (Nanchal et al., 2013). Fernandez et al. (2001) found in their NIV cohort no differences in ICU or hospital length of stay whereas Pallin et al. (2015) found the NIV group and the invasively ventilated group had similar length of stay, both of which were longer than that in the control group. These differences could be accounted for by confounding factors as these studies were all retrospective. The RCTs unfortunately did not provide clarity on this issue as Gupta et al.

(2010) reported a trend towards shorter ICU and hospital length of stay for the NIV group that did not reach statistical significance and no other RCTs used length of stay as a study endpoint. Length of stay should be reviewed as an important research endpoint for several reasons. It is a good indication of cost per patient as longer stays are often a result of complications and adverse events and can also reflect the non-clinical efficiency of a hospital such as delays in consulting or coordinating care (National Health Performance Authority, 2013a). Length of stay additionally affects patients in two ways: those who have unnecessary longer stays can be subject to adverse events and those who are discharged too quickly are at risk of adverse events and readmission (National Health Performance Authority, 2013a). For patients with chronic conditions who experience acute exacerbations such as those with asthma, length of stay is an important outcome measure and should be accounted for in future studies.

The effect of NIV as an adjunct to bronchodilators is also important as bronchodilators are the accepted first-line treatment for acute asthma (National Asthma Council, 2016). Short-acting β_2 -adrenoreceptor stimulants such as salbutamol are important for bronchospasm relief in asthma (MIMS Australia, 2016). This systematic review included three studies that used nebulised aerosols as an adjunct treatment for both the NIV and control groups (Brandão et al., 2009; Galindo-Filho et al., 2013; Pollack et al., 1995). Two of these studies found an improvement in spirometric values and respiratory rates in the patients receiving NIV compared to the control group (Brandão et al., 2009; Galindo-Filho et al., 2013). The third study found an improvement in spirometric values for the NIV group but no difference in cardiopulmonary parameters (Pollack et al., 1995). Galindo-Filho et al. (2013) additionally examined radio-aerosol pulmonary deposition but found no significant differences between the two groups. This is in agreement with another study that compared radio-aerosol deposition in BiPAP, CPAP and spontaneous breathing and found no difference in deposition of aerosols in healthy subjects (Maccari et al., 2014). Due to airway bronchoconstriction and mucous plugging in asthma, it is likely aerosol deposition is affected by asthma and therefore it would be worthwhile further examining this treatment in patients with acute asthma.

There is a paucity of evidence regarding the effect of NIV on dyspnoea and respiratory rates, particularly in acute asthma. Dyspnoea is an important clinical parameter as it reflects patients' work of breathing and comfort. It has been suggested that the application of NIV

to patients in acute respiratory distress can reduce work of breathing by alveolar recruitment, reduction in elastic work and reducing the threshold load created by intrinsic PEEP (Duke & Bersten, 2009). In this review, only Soma et al. (2008) examined the effect of NIV on dyspnoea. They found the NIV groups reported an improvement on the Borg dyspnoea scale. This is similar to other research that has reported a favourable reduction in dyspnoea in patients with COPD when NIV was applied (Smith, Davidson, Lam, Jenkins, & Ingham, 2012) and may be relatable to acute asthma due to the similar mechanism of pathophysiology such as bronchoconstriction and lower airway obstruction.

It is notable that this systematic review found that NIV use for patients with acute asthma is safe. The retrospective studies show low rates of complications experienced by patients with asthma who were treated with NIV (Fernandez et al., 2001; Nanchal et al., 2013; Pallin et al., 2015) and the ability of NIV to correct the acute respiratory failure experienced by these patients (Meduri et al., 1996; Pallin et al., 2015). These findings are reflected in the literature that has examined the use of NIV for all causes of acute respiratory failure. Researchers have found that first-line NIV is successful in 78% of patients with acute respiratory failure of any cause (Schnell et al., 2014). They have also found that the success rate has increased from 69% to 84% from 1997 to 2011 (Schnell et al., 2014). The improving success rates may be a result of increased awareness and knowledge of NIV as a therapeutic tool. Several authors have remarked on the increasing use of NIV and this has similarly been reflected as an increasing use of NIV for acute asthma (Murase et al., 2010; Nanchal et al., 2013).

2.2.5 Limitations

This literature review was limited by the heterogeneous nature of the studies that were available and thus the inability to conduct meta-analysis of the RCTs and difficulty comparing outcomes (Onwuegbuzie & Frels, 2016). There may also have been limitations in the researcher's search of databases such as inappropriate or inadequate key terms or Boolean logic which may have omitted some relevant research (Phelps, Fisher, & Ellis, 2007). The review was also restricted by the inability to search grey literature not available online. Studies that were not available in full text English were unable to be included in this review which further affected the findings. There are also limitations associated with the quality appraisal tools used. There are few tools available for quality appraisal of observational studies that have been rigorously tested for reliability and validity. The

GRACE Checklist has been tested for validity but not for reliability which limits the efficacy of the tool (Dreyer et al., 2014).

2.2.6 Conclusion

The results of this systematic review indicate that there is currently insufficient evidence to recommend the use of NIV for acute asthma instead of standard medical therapy alone. It appears that NIV is a feasible and safe option for patients with asthma who are diligently monitored but the effect of NIV on mortality, length of stay and dyspnoea scores is not conclusive. Current evidence shows a trend to better outcomes, decreased adverse events and decreased invasive interventions for these patients when treated with NIV instead of only standard medical therapy, but the significant variation in study endpoints used make generalisations impossible. There is a need for further research to be conducted before definitive recommendations can be made regarding the use of NIV to treat acute exacerbations of asthma.

2.3 Phase 2 Literature Review: The Experiences of Nurses Using NIV

The previous section of this chapter focused on the literature that examined whether the use of NIV for acute exacerbations of asthma provides better clinical outcomes compared to standard medical therapy. As has been previously stated, the use of NIV to treat patients with acute asthma does currently occur. Nurses are integral to the initiation, monitoring and ongoing care of these patients. Several barriers to the use of clinical technology have previously been identified and shown to have an effect on nursing practice (Eley, Fallon, Soar, Buikstra, & Hegney, 2009; Gerrish et al., 2006; Jeskey et al., 2011). Due to this, it is important that the experiences of nurses using NIV are examined to determine if there are factors other than the efficacy of the treatment that affect the likelihood they will use it. Knowledge of factors that inhibit or assist nurses to use NIV can be used together with information about clinical efficacy of the treatment to design best practice standards. The second phase of Chapter 2 is focused on the literature that has examined the experiences of nurses using NIV.

2.3.1 Aim

The aim of this literature review was to examine the current available research focused on the nurses' experiences of using NIV in acute care.

2.3.2 Methods

Database searches were conducted using EBSCOhost, MEDLINE and Science Direct. Search terms used were combinations of ‘nurs*’ or ‘experience*’ with ‘noninvasive ventilation’, ‘non invasive ventilation’, ‘BiPAP’, ‘CPAP’ or ‘positive airway pressure’. Inclusion criteria were studies that focused on the experiences of nurses using NIV, were published in English and were those with research designs. There was no limit set on date of publication. Studies were initially shortlisted for inclusion based on article title. Abstracts were then examined against the inclusion criteria and relevant papers shortlisted again. At the time of full text evaluation, a review of the reference list was also undertaken to identify any omitted relevant research.

The studies that met the inclusion criteria were individually examined and rated according to the Joanna Briggs Institute Critical Appraisal Checklist for critical and interpretive research (Lockwood, Munn, & Porritt, 2015). This appraisal checklist was designed by the Joanna Briggs Institute and subject to peer review. Its purpose is to provide reviewers with a systematic process to follow when critiquing research (Lockwood et al., 2015). The review tool is accompanied by a discussion of the critical appraisal criteria. All research examined in this literature review was subject to the application of the critical appraisal criteria to determine its methodological rigour. In addition to the four studies that used interviews for data collection, four studies were found that had used questionnaires to examine nurses’ experiences.

2.3.3 Results

The literature search returned a possible 279 matches which were shortlisted according to title and then again by abstract content before being reviewed in full. An additional two matches were found after review of reference lists. Figure 2.2 shows the selection process that was undertaken as per the PRISMA reporting flow chart (Liberati et al., 2009). Eight articles were included in the final review of which four were qualitative studies and four were descriptive studies.

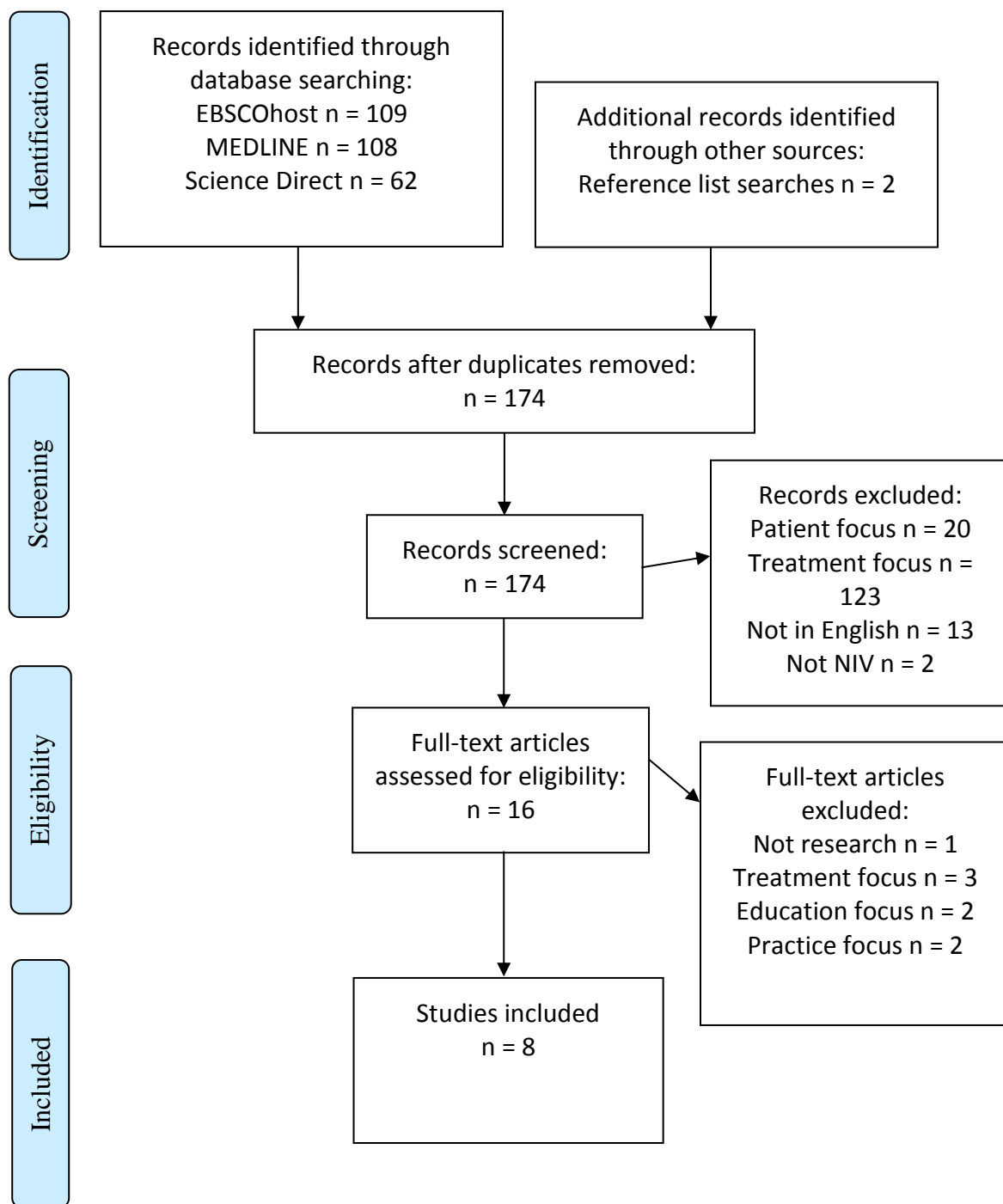


Figure 2.2 PRISMA flow chart of qualitative studies – Phase 2 literature review
 Source/Note: Liberati et al., 2009

The four qualitative studies that examined nurses’ experiences using NIV were vastly different. Firstly, the studies examined the perspectives of nurses from a variety of settings in which NIV was used. Using semi-structured interviews with health professionals, Baxter et al. (2013) examined their experiences in the use of NIV at the end-of-life in patients with motor neurone disease. Sinuff, Kahnamoui, Cook, and Giacomini (2007) also conducted

semi-structured interviews, however, they focused on the experience of healthcare staff using the NIV guidelines as a tool for their practice in acute care. Conversely, Sørensen et al. (2013a) had informal conversations with nurses in the ICU while they were working to examine how nurses collaborated with patients when using NIV as a treatment. Finally, Sørensen, Frederiksen, Groefte, and Lomborg (2013b) used interviews with critical care nurses to determine nurses' clinical reasoning and actions when treating a patient with NIV.

None of the researchers discussed the philosophical assumptions underpinning the design of their research projects. Despite this, with the exception of Baxter et al. (2013), they did link their work to theory. The use of theory in nursing research is significant as research without theory can produce isolated information (Alligood, 2018). Two of the studies reviewed used grounded theory (Sinuff et al., 2007; Sørensen et al., 2013a). This requires the researcher to generate theory as the outcome of a project. Sørensen et al. (2013b) used interpretive description which was described by Thorne, Kirkham, and MacDonald-Emes (1997, p. 173) as a noncategorical qualitative research approach that follows general principles for analytic frameworks, sample selection, data sources, data analysis and rigour.

Only two of the studies, both of which were conducted by the same group, gave a statement regarding the researcher's stance. In the research conducted by Sørensen et al. (2013b), the observational data were collected by a researcher who was a former intensive care nurse. She also performed the six interviews. The same group conducted the research reported by Sørensen et al. (2013a) and reported the same person had collected the data. The researcher is integral to qualitative research and has a role within the data collection and analysis. The relationship of the researcher with qualitative research introduces strategic, ethical and personal issues into the research process (Creswell, 2014). For this reason, it is important that qualitative research declares biases, values and personal backgrounds (Creswell, 2014).

Due to the broad range of designs and specialties in which the research was conducted, there were many variable findings. Interestingly, there were also similar themes identified by the researchers. Many of the nurses who were interviewed discussed their use of guidelines when using NIV. The difference was that some of them were in favour of utilising the guidelines, some of them were not, and others stated they had limited or no knowledge of the guidelines (Baxter et al., 2013; Sinuff et al., 2007).

Education was commonly mentioned. Many nurses felt they had not been given adequate training to care safely for patients on NIV. For example, in the research conducted by Sinuff et al. (2007) only 27% of staff indicated that they received education about the NIV guidelines and only 30% had formal education about NIV. In spite of (or perhaps due to) the lack of education received, the nurses described gaining confidence through experience. Sørensen et al. (2013b) demonstrated how nurses used their intuition and years of experience to make decisions. Past situations were used by the nurses as a basis for their practice and assisted them to anticipate complications in their patients' clinical progression (Sørensen et al., 2013b).

There was also a common theme of communication, both positive and negative. Two of the healthcare professionals interviewed by Baxter et al. (2013) identified that the NIV mask could muffle the patient's attempts to communicate. This was directly contrary to the finding by Sørensen et al. (2013a) who stated some of the nurses they studied were skilled enough that they could react to nonverbal cues that indicated their patients were uncomfortable. Several models of collaboration between nurses and their patients have also been suggested by Sørensen et al. (2013a), however, the researchers did note that in some instances, collaboration did not occur. An appraisal of the four qualitative studies reviewed can be found in Table 2.5.

Table 2.5 Appraisal of the four qualitative studies

Appraisal questions	Studies*			
	1)	2)	3)	4)
Is there congruity between the stated philosophical perspective and the research methodology?	U	U	U	U
Is there congruity between the research methodology and the research question or objectives?	Y	Y	Y	Y
Is there congruity between the research methodology and the methods used to collect data?	Y	Y	Y	Y
Is there congruity between the research methodology and the representation and analysis of data?	Y	Y	Y	Y
Is there congruity between the research methodology and the interpretation of results?	Y	Y	Y	Y
Is there a statement locating the researcher culturally or theoretically?	N	N	Y	Y
Is the influence of the researcher on the research, and vice versa, addressed?	N	N	N	N
Are participants and their voices adequately represented?	Y	Y	Y	Y
Is the research ethical according to current criteria or for recent studies and is there evidence of ethical approval by an appropriate body?	Y	Y	Y	Y
Do the conclusions drawn in the research report flow from the analysis or interpretation, of the data?	Y	Y	Y	Y

Key: Y = yes; N = no; U = unclear; NA = not applicable
*1) Baxter et al., 2013; 2) Sinuff et al., 2007; 3) Sørensen et al., 2013a; 4) Sørensen et al., 2013b

Source/Note: Lockwood, Munn, & Porritt, 2015

In addition to the qualitative studies, four studies were found that had used questionnaires to explore the experiences of nurses using NIV. These studies also used vastly different research questions and locations. Foster et al. (2008) used questionnaires to examine how nurses' perception of workload intensity in special care nurseries differed between using CPAP and head box oxygen. Nurses completed surveys at the end of their shifts on their perception of their workload that shift. It was found that the presence of casual staff and time spent with an individual baby during a shift significantly increased the nurses' perception of increased workload. No significant difference was found between CPAP and head box oxygen on perceived nurse workloads.

Dieperink et al. (2008) studied nurses' experiences implementing NIV as a new model of care in coronary care units. Nurses completed surveys immediately after being trained on the use of NIV and then two years after the implementation of the treatment into their practice. Unfortunately, this research was more focused on the experiences of the patients with whom semi-structured interviews were conducted; little data were collected from the nurses. Dieperink et al. (2008) did determine that the nurses did not always use the treatment as per the treatment protocol. Reasons given for this were the decision of the physician, the lack of international guidelines, clinical improvement in patients without Boussignac CPAP, the more intensive nature of Boussignac CPAP and the belief that Boussignac CPAP treatment created major discomfort for patients (Dieperink et al., 2008).

In a later study, Dieperink et al. (2009) examined the implementation of Boussignac CPAP into the model of care for the ambulance service in one area of Denmark. In this area, ambulances were staffed by nurses. Eight months after the introduction of the Boussignac CPAP into the ambulances the nurses were surveyed about their experiences. Again, this study focused heavily on the treatment outcomes of patients (who were also surveyed) and very little was reported about the experiences of the nurses other than that 91% (of the 22 nurses surveyed) were positive about using Boussignac CPAP as a treatment and felt it was feasible, effective and had had no technical or logistical issues.

Cabrini et al. (2009) surveyed nurses working on general wards about their experiences using NIV within the general ward setting. This survey indicated that nurses often did not feel they were part of the decision-making process and half of them did not feel they were adequately informed about decisions. Similar to the findings of other researchers (Baxter et al., 2013; Dieperink et al., 2008; Sinuff et al., 2007), one third of the nurses in Cabrini et al.'s study (2009) felt that the doctors making the decisions regarding the use of NIV did not perform an adequate number of consultations. Cabrini et al. (2009) also found that the majority (87%) of the general ward nurses using NIV to treat patients felt their training was inadequate. In these instances, instead of relying on doctors, the nurses often relied on more senior nursing colleagues to assist them with NIV-related problems (Cabrini et al., 2009).

Table 2.6 summarises the methodological characteristics and findings of the research included in Phase 2 of the literature review. As has been discussed, some of the studies examined nurses as part of a larger group, including patients (Dieperink et al., 2008) and other healthcare professionals. As this review was focused on the experiences of nurses, the

results pertinent to the nurses have been exclusively discussed unless they were analysed as a part of a larger group.

Table 2.6 Methodological characteristics and findings of the studies – Phase 2

Author/Date	Sample	Method of data collection/analysis	Findings
Baxter et al., 2013	Healthcare professionals who had cared for patients with motor neurone disease using NIV at end-of-life 15 healthcare professionals including eight nurses	Semi-structured interviews Thematic analysis	Uncertainty amongst healthcare professionals regarding how to manage the NIV Positive impacts of NIV use for end-of-life care Two patients receiving end-of-life care were subjected to cardio-pulmonary resuscitation
Cabrini et al., 2009	90 surveys completed by nurses working across four non-intensive wards	Surveys Statistical analysis	67% of nurses did not feel they were involved in the decision-making process Half of the nurses felt they were inadequately informed about decisions made One third of nurses felt there was inadequate consultation by the treating doctors 13% of nurses stated their NIV training was adequate
Dieperink et al., 2008	34 coronary care unit nurses at first time point 33 coronary care unit nurses at second time point	Surveys Descriptive results	There were four issues with noncompliance with Boussignac CPAP protocols identified by nurses: Physician's decision Patient improvement before Boussignac CPAP was applied The more intensive nature of Boussignac CPAP The belief that Boussignac CPAP caused patient discomfort
Dieperink et al., 2009	22 ambulance nurses surveyed up to eight months after the	Surveys Descriptive results	91% of the surveyed nurses were positive about the practical feasibility and effectiveness of using Boussignac CPAP

Author/Date	Sample	Method of data collection/analysis	Findings
	implementation of Boussignac CPAP		
Foster et al., 2008	281 surveys from 71 nurses working in a special care nursery	Surveys Statistical analysis	Comparison of workloads for nurses in special care nurseries when using CPAP compared to head box oxygen showed no significant difference Nurses preferred CPAP over head box oxygen
Sinuff et al., 2007	30 clinicians including 12 nurses who used NIV for COPD and congestive heart failure	In-depth, semi-structured interviews conducted before and after guideline implementation Grounded theory	The NIV guideline was perceived to define individual clinical responsibilities, improve clinician comfort with the use of the machine, increase patient safety and reduce practice variability Barriers to guideline use included lack of awareness, unclear guideline format and reluctance to change practice
Sørensen et al., 2013a	Observation of 21 patients treated by nurses across three ICUs and one general respiratory ward Interviews with 11 patients	Qualitative observation and field notes Informal conversations with nurses Semi-structured interviews with patients Grounded theory	Collaborative typologies were identified between nurses and patients during NIV treatment
Sørensen et al., 2013b	Six experienced intensive care nurses	In-depth interviews Interpretive description and retrospective interpretation	‘Practical wisdom’ is an important component of clinical development and for the education of junior nurses Experienced nurses use intuition during decision-making

2.3.4 Discussion of Nurse's Experiences using NIV

The studies that have focused on the experiences of nurses using NIV have been designed using vastly different research approaches. What they do indicate is the significant effect nurses' experiences had on their own work satisfaction and the outcomes of their patients. The differences in the study designs make it impossible to draw general conclusions from this body of evidence. It is also notable that half of the studies examined did not primarily focus on the nurses as participants.

It is notable that half of the research critiqued in this literature review used surveys as a method of data collection instead of interviews. Surveys can be useful in health research as they allow for a description of the sample to be collated and statistically analysed (Schofield & Forrester-Knauss, 2017). They can also be useful when researchers are examining a phenomenon that is not directly measurable or observable. The issue with using surveys to collect data about a phenomenon such as the experiences of nurses is that surveys cannot capture the same rich data that can be collected using qualitative interviews. For example, the survey administered by Dieperink et al. (2009) asked respondents "Do you think Boussignac CPAP is useful in the ambulance?" The nurses could respond 'Yes' or 'No' but this answer was not able to convey why the nurses thought the treatment was beneficial (or not).

Despite the significant differences in the research projects reviewed, it is interesting to note that the themes of education, communication, collaboration and guideline utilisation were common to many of the findings from both interviews and surveys. This may indicate that these areas are not unique to one particular area or specialty but are common issues across the spectrum of nursing in regards to NIV use.

Education was the most commonly mentioned theme raised by the research included in this literature review. Cabrini et al. (2009) reported the nurses they surveyed in the general ward settings wanted more education on the use of NIV and few of them felt they had been given adequate NIV training. There has been a vast array of research that examined the effect of nurse education on the outcomes of patients (Aiken et al., 2014; Cho et al., 2015). It has been reported that educating nursing staff results in a decrease in patient mortality (Aiken et al., 2014; Cho et al., 2015). The effect of education on nurses and patient outcomes would suggest it is beneficial to provide nurses with adequate training on the use of potentially

lifesaving devices such as NIV. Conversely, it is dangerous to have nurses titrating and monitoring equipment for which they have had no training, as was reported by Cabrini et al. (2009).

Research conducted by Lopez-Campos et al. (2016) further illustrated the issue of untrained staff using NIV in practice. They attempted to conduct an observational study to determine the effect of staff training on the outcomes of patients treated with NIV. They recruited a cohort of patients in a general ward to be cared for by ward staff who had been orientated to NIV and trained in its use once. The study had to be terminated early due to their finding that the use of NIV by inexperienced personnel risked the safety of patients and led to a high rate of NIV treatment failure (Lopez-Campos et al., 2016). Although there are many factors unique to the context in which this study took place, it did demonstrate the significant impact of untrained staff on patient outcomes. This highlights the importance of ongoing education when NIV is introduced into practice.

In addition to education, experience was positively associated with the ability to use NIV. Sørensen et al. (2013b) demonstrated the ‘practical wisdom’ that is acquired by nurses through their years of experience. The nurses in their study demonstrated how they could use their intuition to make decisions. They based many of their clinical decisions on past situations and experiential learning. Their experience also helped them to anticipate problems with treatment and therefore prevent them occurring. Sørensen et al. (2013a) found that some of the nurses they studied were skilled enough to enable them to respond to signs and nonverbal communications of discomfort.

The phenomenon of ‘knowledge embedded in practice’ has previously been described by Benner (1984, p. 3) who stated “Expertise develops when the clinician tests and refines propositions, hypotheses, and principle-based expectations in actual practice situations”. This is what was described by Sørensen et al. (2013b). The nurses had acquired years of practical experience which had moved them into a mode of intuitive practice. Although at times the nurses were unaware of their ‘practical wisdom’, it was commonly practised. Benner (1984, p. 36) defines this type of experience not as the passage of time but rather the effect continuous exposure has on a nurse’s ability to work within those situations. Sørensen et al. (2013b, p. 177) gave an example of this in their research, stating “The nurses intuitively decided, which (NIV) mask to use; it was not a random choice or based on a guess. On the contrary, the decision was based on their perceptions of the masks and the patients’ faces”.

This is a clear example of ‘practical wisdom’ and exemplifies the intuitive clinical work of experienced nurses. Benner, Tanner, and Chesla (1992) found this in their own exploration of expert nurses and described the practice of expert nurses as incorporating an inherent clinical wisdom gained from years of experience.

The research by Cabrini et al. (2009) suggested that nurses commonly consult with one another when having difficulty with NIV rather than waiting for a doctor to attend which has time delays. This further supports the idea that nurses are not only responsible for initiation, titration and monitoring of NIV, but also, they take responsibility for problem solving. Other research has examined the phenomenon of nurse-nurse collaboration and what it actually means for nurses to collaborate with one another (Moore, Prentice, & Taplay, 2015). Nurses see collaboration as consultation and using each other’s expertise to complete their work together. Communication has been identified as an important factor in collaboration (Moore et al., 2015). High rates of collaboration have also been linked to lower intent to leave, higher job satisfaction and better quality of patient care (Ma, Shang, & Bott, 2015).

The topic of collaboration in regards to NIV treatment is not limited to collaboration between nurses but was also demonstrated to occur between the nurse and the patient. Sørensen et al. (2013a) discussed the collaboration between nurses and patients during NIV treatment and identified four different models of collaboration. They were: the twofold collaboration in which the nurse and patient worked together to optimise patient comfort and treatment success; the well-being orientated collaboration where the nurse and patient collaborated to improve the patient’s well-being and tolerance of NIV to achieve success; the outcome-orientated collaboration where the nurse and patient collaborate to improve the patient’s benefit of the treatment; and finally, the absent collaboration in which the nurse and patient did not collaborate to reach common goals (Sørensen et al., 2013a).

The use of NIV guidelines for clinical practice was commonly mentioned in the literature although in varying forms as some staff reported they commonly used guidelines and others admitted they did not realise guidelines existed. Access to guidelines and the way they were used seemed to affect the experience of nurses using NIV, in different ways. The staff interviewed by Baxter et al. (2013) stated they rarely utilised guidelines in their practice which was a similar finding to that of Dieperink et al. (2008). It was suggested by the nurses that instead of simply following NIV guidelines in every situation, there were instances when their patients’ care had to be tapered to individual circumstances. In another study, the NIV

guideline implemented by Sinuff et al. (2007) was reported to be commonly used, however, the nurses applied the guideline in different ways to get the outcome they desired. For example, nurses reported they used the NIV guideline to correct the decisions of other clinicians who were not using NIV according to the guideline criteria. Other staff reported they were unfamiliar with the guideline available and in keeping with the findings regarding education on NIV, only 27% of staff indicated they received education about the NIV guideline (Sinuff et al., 2007).

Other research in this literature review has discussed reasons why clinicians do not utilise best practice guidelines. Cabana et al. (1999) suggested the three main culprits are knowledge (lack of familiarity or awareness), attitudes (lack of motivation, agreement and efficacy) and behaviour (patient factors, environmental factors, guideline factors). The findings from this review as to why clinicians do not follow guidelines generally fit within these categories with one exception. This review found that some clinicians may not follow guidelines because they instead follow their intuition.

The notion that staff may not follow guidelines due to conflicting evidence is particularly pertinent in regards to NIV. Internationally, there are several clinical guidelines that have been written for the purpose of assisting staff to care for patients utilising NIV (Chawla et al., 2013; Keenan et al., 2011; Sanchez et al., 2014). Unfortunately, the guidelines differ in their recommendations for the use of NIV in treating asthma. For example, the latest guidelines published by the British Thoracic Society for the use of NIV recommend it not be used routinely as a treatment for asthma (Davidson et al., 2016). This is directly contrary to the recommendation by the Indian Society of Critical Care that NIV should be used for acute asthma (Chawla et al., 2013). The guidelines for NSW, Australia (Sanchez et al., 2014) are different again and recommend NIV be used for acute asthma in some specialty areas only and with caution. With a vast array of conflicting recommendations, it is predictable that staff may become confused regarding what constitutes best practice and which guidelines should be followed.

The research examined in this literature review mostly reported that staff found NIV to be a beneficial and effective tool when used correctly. The nurses working in special care nursery who were surveyed by Foster et al. (2008) reported they preferred to use CPAP on their patients compared to head box oxygen. Similarly, Dieperink et al. (2009) found the majority of nurses surveyed had positive experiences using Boussignac CPAP. The only negative

experiences reported about the use of NIV in the treatment of acute asthma in this review of the literature were by the nurses studied by Baxter et al. (2013). They described two instances where patients receiving end-of-life treatment, which included NIV for symptom relief, were resuscitated against their wishes as stated in their advanced care directives. Although the presence of NIV may have indicated to healthcare staff that the patients were still for active treatment measures, including resuscitation, it is unlikely that the presence of NIV alone would have caused this issue. It is more likely a result of miscommunication by staff of the patient's advanced care directive. The issue of patients with do-not-resuscitate orders being resuscitated is not new and is commonly reported to be due to issues with documentation and communication (Berger, Zelman, Muir, Amaya, & Ershova, 2017; Robinson, Cupples, & Corrigan, 2007; Yuen, Reid, & Fetters, 2011).

The experiences of nurses using NIV described in this literature review can be compared to broader research that has examined nurses' experiences with technology. Since the introduction of technology to nursing there has been debate on whether technology enhances or dehumanises nursing care (Leininger, 1988; Sandelowski, 1988). Past research has reported technology may dehumanise nursing or inhibit the relationship between the nurse and patient (Alasad, 2002; de Veer, Fleuren, Bekkema, Francke, 2011). In 2001, Barnard and Sandelowski (2001) presented the idea that the perceived dispute between nursing and technology was not due to the technology itself but to the organisational and individual contexts in which it was used. The findings of this review corroborate this idea as nurses generally reported no issues with the technology of NIV itself rather they had issues with the lack of education and collaboration in their workplace.

McGrath (2008) conducted a study to determine the experiences of critical care nurses using technology. They found that the nurses embraced technology and supported each other to use it. The nurses also commented that the requirement for 'high tech' care meant they were closer to their patients as they spent a lot of time at the bedside (McGrath, 2008). The issues the nurses raised were focused on the need for education and assistance from experienced staff; they also had differing views on when technology should be used or withdrawn, compared to the views of doctors (McGrath, 2008). Tavares, Torres, Souza, Pereira, and dos Santos (2013) also investigated the effect technology had on nursing, using semi-structured interviews. They found that, in general, the nurses had positive feelings towards using technology, but issues arose when they were not provided with adequate training on the

equipment, had limited resources (such as equipment manuals) and the technology was not adequately maintained (Tavares et al., 2013). Other recent research has also highlighted the influence of context on nurses' ability to use technology (Crocker & Timmons, 2009; Lavin, Harper, & Barr, 2015). It appears that research focused on nurses' experiences with general technology highlights the same issues that have been raised by research focused on the use of NIV in practice, such as a lack of education and need for collaboration.

2.3.5 Limitations

This literature review was limited by the paucity of published research that has examined the experiences of nurses using NIV and the diversity of research designs used to investigate this issue. Half of the studies used surveys (Cabrini et al., 2009; Dieperink et al., 2008; Dieperink et al., 2009; Foster et al., 2008), making it impossible to draw qualitative conclusions about experiences. Two of the studies did not solely focus on the nurse (Sinuff et al., 2007; Sørensen et al., 2013a) and provided little information about their individual experiences. There may also have been limitations in the reviewer's search of databases such as inappropriate or limited key terms or Boolean logic used and therefore some relevant research studies may have been omitted (Phelps et al., 2007). Finally, the review was limited by the inability to search grey literature not available online; also studies not available in full text English were unable to be included in this literature review and this further limited the findings.

2.3.6 Conclusion

This literature review on the experiences of nurses in using NIV for the treatment of acute exacerbations of asthma has shown that there is limited evidence available on this topic. There is a paucity of studies that focus on this issue and the research that has been published was conducted in significantly different clinical areas and did not always focus primarily on the nurse. The available literature has highlighted that nurses generally believe NIV is an effective clinical tool in the treatment of acute asthma but they also identified that the implementation of NIV is associated with issues around lack of education provision, need for collaboration and guideline variability. Further research is required to determine the experiences of nurses working with NIV.

2.4 Literature Integration of Phase 1 and Phase 2 and Chapter Summary

It is evident from the two phases of this literature review that there are significant gaps in the published literature that has examined the use of NIV for acute exacerbations of asthma and the experiences of nurses using this treatment. Many of the studies that focused on the use of NIV for asthma conducted their research in EDs but did not follow the patient through their admission to capture outcomes such as length of stay or mortality. This literature review concluded there is not enough evidence to conclusively recommend the use of NIV for acute exacerbations of asthma. Despite this, the literature and nursing practice of the author have revealed that this practice does commonly occur.

This chapter also reviewed the literature that examined nurses' experiences using NIV. It is evident from this review that there is a paucity of evidence on the experiences of nurses using NIV. The available literature emphasises the importance of context on the nurses' practice and identifies it as being more important to the nurses than the technology itself. Education, collaboration and guidelines were identified as the most influential factors for the nurses' successful use of NIV. Isolated knowledge of the efficacy of a treatment is not enough to enable clinicians to use it successfully in practice. It is equally important to gain an understanding of how technology is implemented and used in practice and the factors that inhibit or enhance the ability of nurses to use it in practice.

Due to the paucity of evidence on the use of NIV for acute exacerbations of asthma, the disparity in research designs and study endpoints, and the limited evidence regarding the experiences of nurses using NIV in practice, there is a requirement for new evidence to address these topics. The research project outlined in the subsequent chapters was designed as a result of these findings and aims to determine both the efficacy of the use of NIV for acute exacerbations of asthma and the experiences of nurses using the treatment. The next chapter will examine the philosophical and methodological assumptions underpinning the design of this project.

Chapter 3: Philosophical Assumptions and Methodology

3.1 Introduction

This chapter examines the philosophical assumptions associated with Deweyan pragmatism that were used in the design of this project. Briefly, pragmatism is a process-oriented philosophy that judges the value of an idea or theory by how practically useful it is. Pragmatism aims to gain knowledge in things as they present themselves, particularly in relation to context (Dewey, 1908). The stance of this research in regards to truth, realism, fallibilism, anti-scepticism, experience, inquiry, instrumentalism and naturalism will be discussed. Additionally, the use of phenomenology within the assumptions of pragmatism will be outlined. The methodological design that resulted from the employment of these assumptions will be described including the history and application of mixed methods. The chapter will conclude with identification of the position of the researcher within the project.

3.2 Historical Evolution of Pragmatism

In congruence with the reasons for development of many other philosophies, pragmatism was developed as a reflection of the context of the time and changes in knowledge (Webb, 2007). The most pivotal contextual issues were the end of the American Civil War and the publication of Darwin's *Theory of evolution* (Webb, 2007, p. 1066). America, at this time, was still a deeply religious society and the dominance of theology had previously limited scientific progression (Ormerod, 2006, p. 894). Charles Sanders Peirce and John Dewey had, until this time, been philosophers of different accords but these societal and scientific events had a significant effect on their philosophical orientations (Webb, 2007, p. 1066). In particular, the scientific breakthroughs of Darwinian theory had transferable effects on philosophical thought. This is summarised by Webb (2007, p. 1066):

- (1) Before the publication of Darwin's theory, "Each different species of living organism once was thought to be an immutable natural kind". When Darwin showed that, in fact, species were constantly evolving it suggested to philosophers the mutability of knowledge. This transferred to the philosophical thought that knowledge was fallible.
- (2) Evolutionary theory suggested that, like every other animal species, humans had evolved over time. Due to this likeness

- with other species, it seemed philosophically flawed to suggest that the behaviour of the human species should be treated metaphysically, as if in a separate realm. According to evolutionary theory, humans are merely another natural species.
- (3) Darwin suggested that species evolve rather than adapt. If this is comparable to the accumulation of knowledge, then it suggests the process is never completed or perfected.
 - (4) Controlled, scientific experiments became more prominent as a consequence of Darwin's work.

Influenced by these changes, Peirce developed a “philosophy of meaning, with the meaning of any concept that has application in the real world lying in the relations that link the experiential conditions of applications with observable results” (Ormerod, 2006, p. 892).

Around the same time, the university system in America was still developing and intellectuals had limited opportunities to meet for the purpose of academic discussion. To address this, private philosophical and literary societies developed so intellectuals could socialise and hold these discussions (Ormerod, 2006, p. 894). In 1872, Charles Sanders Peirce formed a conversation society in Cambridge, Massachusetts, which subsequently became known as the Metaphysical Club (Menand, 2001). Club members included Chauncey Wright (1830–1875), Oliver Wendell Holmes (1841–1935), Charles Sanders Peirce (1839–1914), and William James (1842–1910) (Menand, 2001).

As a result of conversations and contributions to the Metaphysical Club, Peirce wrote *The fixation of belief* (1877) and *How to make our ideas clear* (1878). These papers signified the beginning of pragmatism although they were not identified as such until *How to make our ideas clear* was defended by William James during a meeting of the Philosophical Union at the University of California in 1898 (Hookway, 2013). This was probably because Peirce did not label his new philosophy ‘pragmatism’; the term was first used by James during his Philosophical Union address (Hookway, 2013). James continued to contribute to the philosophy through his work such as *Pragmatism: A new name for some old ways of thinking* (1907) and *The meaning of truth: A sequel to pragmatism* (1909) although he maintained that the original conception of pragmatism was from Peirce. James (1907, p. 45) presented pragmatism as a “method of settling metaphysical disputes that otherwise might be interminable ... if no practical difference whatever can be traced, then the alternatives mean practically the same thing, and all dispute is idle”.

The third significant figure in the development of pragmatism was John Dewey. Peirce's philosophical work was largely confined to scientific areas where he made significant contributions through his original work in logic, the theory of signs and the metaphysics underlying scientific inquiry (Webb, 2007, p. 1067). It was Dewey who turned to societal context to influence his philosophy. During reflection on his 1920 publication *Reconstruction in philosophy*, Dewey (1948) shows the strong emphasis he places on philosophy being a consideration of societal context. He stated in his reflection "The distinctive office, problems, and subject matter of philosophy grow out of stresses and strains in the community life" (Dewey, 1948, p. iii). As a result of his beliefs, it was Dewey who translated the philosophy of pragmatism to address practical, ethical and aesthetic issues (Webb, 2007, p. 1067).

The pragmatism offered by Dewey can be better understood after an examination of his life and the context in which he existed. John Dewey (1859–1952) was born in Burlington, Vermont, the third of four sons of a middle-class couple (Dewey, 1939). At the age of 15 years, he graduated from high school and subsequently enrolled in the University of Vermont where he was educated on what was known as 'Burlington philosophy', a transcendental philosophy based on the superiority of 'free intuition' (Ormerod, 2006, p. 900). When he graduated from Vermont, Dewey became a teacher, first at a secondary school and later at a village school (Dewey, 1939). In 1884, he gained a Doctor of Philosophy (PhD) at Johns Hopkins University where he had worked with George Sylvester Morris and became a Hegelian (Ormerod, 2006, p. 900). For the next ten years, Dewey worked at the University of Michigan (with the exception of one year at the University of Minnesota), before moving to the University of Chicago in 1894 (Field, 2005). It was there, in Chicago, that several important events occurred. Dewey renounced his Hegelian views and began to align with the newly formed pragmatism. He also met Jane Addams (a resident of Hull House) and Ella Flagg Young (a teacher and the first female superintendent of a large American city's school system and the first to be President of the National Education Association). His friendship with these two women, in addition to his wife, advanced his knowledge of society, education and democracy. Dewey also "attributed much of his enthusiasm of his support of every cause that enlarged the freedom of activity of women to his knowledge of the character and intelligence of [these three women]" (Dewey, 1939).

The context of Dewey's life influenced his writings and intellectual contribution to issues he felt were pertinent to the time in which he lived. Apart from his work in education and philosophy, Dewey also became involved in societal, ethical and political issues contributing to ethical theory, social theory and aesthetic theory (Field, 2005). Many have recognised him as one of the most influential characters in American history.

Dewey is credited with contributions to pragmatism that spanned decades but when his career concluded the popularity of pragmatism declined. It did not become largely popular again until its resurrection by contemporary philosophers, most notably Rorty, Quine, Putnam and Habermas (McDermid, n.d.). Although these contemporary pragmatists have contributed significant work to classical pragmatism, it is the work of Dewey that was used to inform this project, in particular his unique emphasis on naturalism and instrumentalism. The philosophical assumptions proposed by Dewey will now be discussed and reference made to their place in the design of this research project. These assumptions include Dewey's stance on truth, realism, fallibilism, anti-scepticism, experience, inquiry, instrumentalism and naturalism.

3.3 The Philosophical Assumptions of Pragmatism

3.3.1 Pragmatist Maxim

Prior to an explanation of the philosophical assumptions of pragmatism a clear definition of what is meant by pragmatism is appropriate. This is most simply accomplished using the works of Peirce and James. First, an examination of the pragmatic maxim is essential. In one of his seminal works, Peirce (1878) proposed three necessary steps to make ideas clear. First, one must locate individual instances of the idea. Next, a definition must be created. The final step, known as the pragmatic maxim, is to:

... consider what effects, which might conceivably have practical bearings, we conceive the object of our conception to have. Then, our conception of those effects is the whole of our conception of the object (Peirce, 1878, p. 292).

As an example, he discussed what is required to determine if an object is hard or soft. He describes this as something that cannot be known until it is 'put to the test' (Peirce, 1878). In his opinion, the perceived effects of something are the practical effects. Unless something makes a practical difference, it makes no difference at all (Peirce, 1878). This is further illustrated in the work of James (1904, para. 1), using a practical example:

Some years ago, being with a camping party in the mountains, I returned from a solitary ramble to find everyone engaged in a ferocious metaphysical dispute. The corpus of the dispute was a squirrel – a live squirrel supposed to be clinging to one side of a tree-trunk; while over against the tree’s opposite side a human being was imagined to stand. This human witness tries to get sight of the squirrel by moving rapidly round the tree, but no matter how fast he goes, the squirrel moves as fast in the opposite direction, and always keeps the tree between himself and the man, so that never a glimpse of him is caught. The resultant metaphysical problem now is this: Does the man go round the squirrel or not? He goes round the tree, sure enough, and the squirrel is on the tree; but does he go round the squirrel? In the unlimited leisure of the wilderness, discussion had been worn threadbare. Everyone had taken sides, and was obstinate; and the numbers on both sides were even. Each side, when I appeared therefore appealed to me to make it a majority. Mindful of the scholastic adage that whenever you meet a contradiction you must make a distinction, I immediately sought and found one, as follows: “Which party is right,” I said, “depends on what you practically mean by ‘going round’ the squirrel. If you mean passing from the north of him to the east, then to the south, then to the west, and then to the north of him again, obviously the man does go round him, for he occupies these successive positions. But if on the contrary you mean being first in front of him, then on the right of him, then behind him, then on his left, and finally in front again, it is quite as obvious that the man fails to go round him, for by the compensating movements the squirrel makes, he keeps his belly turned towards the man all the time, and his back turned away. Make the distinction, and there is no occasion for any farther dispute. You are both right and both wrong according as you conceive the verb ‘to go round’ in one practical fashion or the other”.

This example clearly illustrates how the pragmatic method can be used in practice to solve problems. The underpinning principle is that things are only as important as the practical differences they make. As summarised by James (1904, para. 3):

If no practical difference whatever can be traced, then the alternatives mean practically the same thing, and all dispute is idle. Whenever a dispute is serious, we ought to be able to show some practical difference that must follow from one side or the other’s being right.

Research based on the pragmatic maxim will hence be practically orientated. The value of the product of the research is only measured by how practically relevant that product is. In order to use the pragmatic maxim in research, the philosophical assumptions of the tradition of pragmatism must be made clear. As has been previously discussed, Peirce, James and Dewey had slightly differing views and emphasis on the components of pragmatism. The

following discussion will focus on the philosophical assumptions adopted by Dewey, with reference to the works of James and Peirce where those of Dewey are ambiguous or require further explanation.

3.3.2 Truth

Dewey (1938, p. 345) relied on the definition of truth provided by Peirce as being “The opinion which is fated to be ultimately agreed to by all who investigate ... the object represented in this opinion is the real”. This definition of truth is in keeping with the general assumption of pragmatism that things are only useful insofar as they are practical. The truth is the implication of inquiry. In this way, the ‘pragmatic theory of truth’ allows for multiple truths. One person may have a proposition they believe to be practically useful and true and at the same time another person may hold an opposing proposition they equally believe to be useful and true.

Rather than thoroughly discussing the nature of truth, Dewey (1938, p. 9) described the concept of ‘warranted assertion’. This, he explained, is a term he prefers to that of ‘belief’ or ‘knowledge’ because it recognises the ambiguity of the former words and their inability to account for change (Dewey, 1938, p. 7). He explained that the words ‘warranted assertibility’ were used because “the use of a term that designates a potentiality rather than an actuality involves recognition that all special conclusions of special inquiries are parts of an enterprise that is continually renewed, or is a going concern” (Dewey, 1938, p. 9). Through this definition, Dewey allowed for the existence of multiple and changing truths which was an assumption adopted in this project. The quantitative data provided a truth different to that of the nurses interviewed and every nurse had a different truth, but each unique aspect of the data was accepted individually.

3.3.3 Realism

In Dewey’s paper, *Brief studies in realism* (1911, p. 395), he placed himself in the realm of naïve realism. Here he differentiated between *a* real object (something that is perceived) and *the* real object (something that exists). He noted the importance of the perception of something in relation to its knower (Dewey, 1911, p. 396). The perception of an object is a direct result of the context of the perceiver and therefore it is that perception which provides the experience of the external world. The position of naïve realism allows experience to have a significant influence on knowledge. This relates directly to practical professions such as

nursing. For this project, it emphasised the importance of context on the nurses' experiences. Naïve realism poses that things are real if they are perceived by someone to be so. The world exists independently of humans and knowledge is dependent on interactions with the world.

3.3.4 Fallibilism

The position of Dewey in regards to fallibilism is documented in his 1929 book *The quest for certainty*. In this publication, he discussed the fallibilism of knowledge “Diversity and contradictions give ground for a suspicion that in no case is the ‘knowledge’ in question as self-evident as it is asserted to be” (Dewey, 1929, p. 175). This acceptance of the fallibility of knowledge was in agreement with that explained by Peirce and denotes that “every belief is acknowledged to be possibly false” (Webb, 2007, p. 1069). This research project aligns with this assumption and is based on the premise that knowledge is not final.

3.3.5 Anti-scepticism

Scepticism involves the doubt of all propositions unless they are absolutely certain. Peirce argued that individual context and thought changed perceptual beliefs and so individuals could not trust those beliefs (Hookway, 2013). Due to this, propositions cannot be deemed absolutely certain and doubt cannot be forced into the mind of someone who does not inherently possess that doubt. Pragmatism instead follows anti-scepticism (Hookway, 2012). Put simply, pragmatists do not believe that inquiry can begin with a doubt of everything (Peirce, 1878). Anti-scepticism is particularly pertinent for this project considering the background of the researcher. As a nurse with prior experience and knowledge in the specialty of critical care, it is not possible for the researcher to be sceptical of all knowledge. Instead, prior knowledge and context will be acknowledged in the section of this chapter entitled ‘Positionality’.

3.3.6 Experience

The pragmatic definition of experience reflects the practicality of the philosophy. The ‘experience’ discussed by Dewey is contextual and always begins with a situation (Webb, 2007, p. 1070). This is very relevant to the nursing context where experience contributes extensively to knowledge although Dewey explains that while some experience is also knowledge not all experience can be classified as such. This is due to the tendency for human experience to be guided by habits rather than reflection. Dewey believed that experience can only become knowledge through the application of reflection (Webb, 2007, p. 1071). While

experience begins with a specific situation, it encompasses the history and ongoing transactions between an organism and its environment (Campbell, 1995).

3.3.7 Inquiry

Dewey defined inquiry as “The transformation of a puzzling indeterminate situation into one that is sufficiently unified to warranted assertion or coherent action” (Ormerod, 2006, pp. 900–901). He emphasised the importance of intellectual inquiry that tested hypotheses based on experience that recognised the impact of the social context in which it was situated (Ormerod, 2006, p. 901). In his publication, *Logic: The theory of inquiry*, Dewey (1938) outlined his idea for the method of inquiry. Important considerations for inquiry are described as:

1. Beginning with a situation that is unknown or not defined
2. Identifying that this situation is a problem
3. Defining the terms of the problem and a possible relevant solution
4. Examining the contextual meaning of the inquiry
5. Accepting that fact and meaning are operational (Dewey, 1938).

As was identified in Chapters 1 and 2, the treatment of acute exacerbations of asthma in adults is contentious, particularly regarding the use of NIV. The context surrounding this issue was also examined in these chapters. In line with Dewey’s method of inquiry, this research project also accepts that knowledge is inherently fluid and the findings of this project may not be representative of the future.

3.3.8 Instrumentalism

One of the views that stood Dewey apart from Peirce and James was his instrumentalist view of theories and laws (Delaney & Widdison, 1990, p. 27; Ormerod, 2006, p. 893). Dewey regarded knowledge as an instrument for action rather than an object of disinterested belief (Ormerod, 2006, p. 893). He believed that a person possesses an idea when they are willing to use an object to produce a predictable outcome (Gouinlock, 2017). In this way, ideas and theories are tools that humans can use to enhance their understanding of the world and are only valuable in the event they are practically useful.

3.3.9 Naturalism

Dewey's belief in naturalism is exemplified in his definition of ideas as "essentially intentions (plans and methods), and that what they, as ideas, ultimately intend is *prospective* – certain changes in prior existing things" (1908, p. 86). With this explanation, he conducts a discussion of metaphysics in which he points to knowledge being a consequence of action, rather than pure thought (Dewey, 1908). Instead of a psychological or ontological perspective on thought, Dewey posits that inquiry, and so truth, is derived from practical tasks. He believed that human experience of the world was formed only by the interrelationship of the two (Dewey, 1905). He uses the following example to illustrate this point:

I start and am flustered by a noise heard. Empirically, that noise *is* fearsome; it *really* is, not merely phenomenally or subjectively so. That *is what* it is experienced as being. But, when I experience the noise as a *known* thing, I find it to be innocent of harm. It is the tapping of a shade against the window, owing to movements of the wind. The experience has changed; that is, the thing experienced has changed – not that an unreality has given place to a reality, nor that some transcendental (unexperienced) Reality has changed, not that truth has changed, but just and only the concrete reality experienced has changed (Dewey, 1905, p. 395).

In this example, Dewey is relying on his naturalistic outlook to explain the human action associated with the experience. The interaction of the person with the world is what influences experience and subsequent action. Human thought is a process of nature resulting from an interaction or experience.

3.4 Pragmatism and Phenomenology: Commensurable or Not?

The preceding discussion has focused on the philosophical assumptions associated with the pragmatism of John Dewey. These assumptions provide a base that guides inquiry, but do not offer specific methods. Following on from the pragmatic requirement that the value of inquiry is in its ability to provide practical knowledge, the methodology required for this project was a combination of quantitative and qualitative inquiry. To understand the efficacy of NIV to treat acute exacerbations of asthma, an empirical investigation was required to measure the biometric values associated with acute respiratory failure. This quantitative retrospective review was designed using the assumptions of pragmatism. The retrospective collection of data is a practical task that enabled the researcher to collect data associated with the application of NIV, but to make this practically relevant, the efficacy of NIV was not the

only component of the phenomenon that was important. The practical ability of clinicians to use the treatment was an essential component of its efficacy.

To examine the experiences of clinicians using NIV, an approach was required that would enable the researcher to access the first-hand experiences of nurses. Phenomenology was deemed an appropriate methodology for this task. The methodology section of this chapter addresses the components of both the quantitative and qualitative phases of this research project. Before this, it must be recognised that while phenomenology is a method of inquiry, it has also been identified “originally and essentially [as] a philosophical discipline” (van Manen, 2014, p. 22). As such, a brief account of the philosophical assumptions associated with phenomenology must be examined to assess its commensurability with pragmatism.

As a philosophical tradition, phenomenology began with Husserl and continued to be moulded by scholars including Heidegger, Stein, Merleau-Ponty, Sartre, de Beauvoir, Levinas, Derrida, Lingis, Marion, Nancy, Chretien, Serres and Agamben (van Manen, 2014, p. 24). Due to individual understandings and ongoing contributions of original ideas, it is difficult to explicitly define one set of phenomenological assumptions. What can be deduced from the work of Merleau-Ponty (1989, p. vii) is that phenomenology is a philosophy that defines essences such as that of perception or experience. The world exists as something that may be reflected upon and each individual can obtain their own reflection or ‘truth’. Knowledge is obtained from the experience of the world and ‘real’ is what is experienced and can be described (Merleau-Ponty, 1989, pp. ix–xi).

If the congruence of phenomenology and pragmatism was judged purely by the preceding assumptions it could be deemed that they are commensurable. There is, however, one significant point of difference between the two paradigms related to their views on naturalism. As previously discussed, Dewey’s pragmatism accepts naturalism, the idea that human life, as a part of nature, follows the patterns of nature. Phenomenology, on the other hand, such as that described by Husserl, disregards naturalism, opting instead for the absolute priority of the transcendental attitude (Moran, 2008, p. 403). Husserl felt that naturalism was a threat to his transcendental idealism, claiming “The naturalist ... sees nothing but nature and first and foremost physical nature” (2002, p. 253).

The conflicting views of naturalism and anti-naturalism have previously been identified as an issue, particularly for cognitive neuroscientists who wish to use phenomenology to

conduct research (Overgaard, 2004). As a result, there have been some efforts to find a solution to this dualism, described as the process of ‘naturalising phenomenology’ (Petitot, Varela, Pachoud, & Roy, 1999). For the purpose of this project, the premise of Dewey’s naturalism is followed with a caveat that enables naturalism and anti-naturalism to coexist within one project. This is based on the hypothesis proposed by Varela (1996, p. 343) that “Phenomenological accounts of the structure of experience and their counterparts in cognitive science relate to each other through reciprocal constraints”. What this means is that in this project, the ‘external’ and the ‘experiential’ are not viewed as limiting subjects but as matters that can individually and equally inform this research project. In this way, the researcher takes a neutral position on mind/body dualism and instead remains open to the knowledge that may come from either. This solution reflects the general view of pragmatism that researchers should use ‘what works’ practically.

3.5 Phenomenology as a Methodology

The phenomenology used in this research project was phenomenology of practice, as described by van Manen (2014). In his text, van Manen (2014, p. 15) defines phenomenology of practice as “The kind of inquiry that addresses and serves the practices of professional practitioners as well as the quotidian practices of everyday life”. As a methodology, phenomenology generally begins with a phase of wonder (van Manen, 2014, p. 37). The focus then turns to the interpretation and description of a phenomenon in experiential terms. It should, however, be noted that phenomenology is concerned more with questioning and description than with answering or drawing conclusions (van Manen, 2014, p. 29). The value of the questioning lies within the potential for that questioning and description to lead to insights and understanding of that phenomenon (van Manen, 2014, p. 29).

Recognition of the prereflectivity of phenomenology is essential in understanding this methodology. The purpose of the process is to examine the ‘now’ but this is never possible because as soon as it is gazed upon the researcher is already looking into the past (van Manen, 2014, p. 59). Van Manen (2014) also reminds phenomenologists that what this practice is attempting to understand is not the named concept but the existent (van Manen, 2014, p. 52). Another difficulty in phenomenology is that human experience can have meanings that are not able to be captured using language. There are also some feelings and meanings that cannot be traced to any particular moment or incident (van Manen, 2014, p. 37). Additionally, due to the inability to access experience in ‘real time’, phenomenologists

rely on the memory of their participants. The issue with this, identified by Dewey (1948, p. 4), is that memory is not always a “remembering of actual facts”. Memories are affected by experience and emotions. These are all important considerations for a researcher conducting a phenomenological project.

In this research project, phenomenology was used as an inductive process. Rather than the researcher applying a theoretical lens to the phenomenon being studied, the researcher focused on the phenomenon itself. Using this method allowed theory to become an endpoint for discussion in the research project (Creswell, 2014, p. 65). Creswell (2014, p. 66) remarked that phenomenologists often do not employ explicit theoretical orientation, but instead attempt to build the essence of experience from participants. This process was deemed important for this phenomenology of practice as it would allow the data to lead the researcher rather than be constrained within a theoretical lens.

The philosophical assumptions on which this project was based allowed for the existence of multiple truths and emphasised both the importance of context and the recognition that perception is influenced by the ‘knower’. Experience is of foremost importance, specifically the use of reflection on experience to produce knowledge. Both external and experiential information is regarded as important. Taking these assumptions into account, a mixed methods project was designed that used both quantitative and qualitative methodology to answer four research questions concerned with the use of NIV for acute exacerbations of asthma. Van Manen (2014, p. 31) stated that a phenomenological question arises at a time when a certain experience causes one to pause and reflect. This point is pertinent to the relationship between nursing and phenomenology. Nursing is a highly reflective profession. Working in an outcome-focused organisation with funding and staffing inadequacies requires nurses to constantly reflect on their practice.

In critical care, much research is focused on the use of technology for treatments, but there is little research that focuses on the experiences of the staff in using those treatments and how those experiences affect the context of treatment. The research questions that form the quantitative phase of this project were shaped from the literature review and a recognised clinical need. These questions alone may have satisfied the requirements of a research project, however, as a nurse reflecting on clinical experience, the researcher was aware that providing equipment to healthcare staff is one isolated event in the process of implementing new treatments. Anecdotally, new equipment had been observed arriving in hospital units

without being used for significant periods of time. This phenomenon was of interest. The researcher felt that it was important to place context around treatment technologies. To address the complexity of these issues, a mix of both quantitative and qualitative methodologies was required.

3.6 Influence of Philosophy on Project Design

The simplest summation of pragmatism in reference to inquiry is that things are only as valuable as they are practically useful. This is directly related to the purpose of this research project. NIV can only be valuable if it is practically useful in that i) it has an efficacy for beneficial patient outcomes, and ii) it is able to be employed by clinicians. Taking this into consideration, this project was designed to investigate both elements of the practical usefulness of NIV. The philosophical assumptions that have been discussed are embedded within the project. Foremost is the belief there can be multiple truths in this inquiry. This is related to the contextual differences in the areas in which NIV is used. Quantitative data were collected from several sites and what is ‘true’ and hence practically relevant for one site may not be so for others. Similarly, the qualitative inquiry may find multiple truths in the experiences of the nurses. The fallibilism of the knowledge gained from this inquiry relates to it being subject to change over time. This is particularly pertinent considering the speed in which health care changes. The results will be considered in light of this assumption. Finally, the context of the inquiry plays a pivotal part in the understanding of the use of NIV and the experiences of the nurses. Due to this, the context of the research project has been explicitly described in Chapter 1 and will be further explored in Chapter 5. Now that the philosophical assumptions underpinning this project have been defined and positioned, the history and design of mixed methods will be discussed.

3.7 Mixed Methodology

The history of mixed methods has been described by Tashakkori and Teddlie (2003). They divided the progression of mixed methods through the 20th century into four eras. The first period from 1900 to 1950 was a relatively uncontroversial time. Researchers were successfully mixing quantitative and qualitative typologies without describing their methods as ‘mixed’. The failure of researchers to label their research as mixed methods may explain why during this period mixed methods received limited attention. Other explanations for the oversight of mixed methods in this time period have been given by Platt (1996) and Maxwell

(2016). Platt (1996, p. 260) stated that much of the written history of research has originated from myth created “to legitimate contemporary preferences” (p. 267). Maxwell (2016, p. 13) further argued that researchers describing mixed methods would rather describe it as a “new and exciting development, a ‘third paradigm’ for social research, than to acknowledge that people have been doing mixed method research for centuries, and far more broadly than most mixed method work recognises”. Despite what may be described in history books, inductive research that involved description and study of single events has been documented as occurring well before 1950 (Maxwell, 2016).

The period 1950 to 1970 is easier to define because this period of time involved the “debunking of positivism” (Tashakkori & Teddlie, 2003, p. 6). After World War II, researchers became increasingly disconcerted with the axioms of positivism and searched for a new paradigm that would enable tenets such as value and theory-laden inquiry and a discussion of the nature of reality, thus postpositivism, emerged (Tashakkori & Teddlie, 2003, p. 6). Researchers began to describe their projects as multimethod or mixed as they continued to combine methodologies in projects such as ‘The robber’s cave experiment’ (1961) and Zimbardo’s (1969) ‘prison’ studies of deindividuation (Tashakkori & Teddlie, 2003). Campbell and Fiske (1959) also contributed to mixed methods in this period with their systematic development and discussion of triangulation.

Tashakkori and Teddlie (2003, p. 6) described the period from 1970 to 1990 as “The ascendance of constructivism, followed by the paradigm wars”. During this period, researchers diverged into two groups – those who began to question purist paradigms and embrace mixed methods and those who argued for the inability to combine methods. As this divergence occurred there was also growing popularity for constructivism and qualitative methods (Tashakkori & Teddlie, 2003, p. 7). Howe (1988) was first to coin the term ‘incompatibility thesis’, a name given to the growing idea (an idea he opposed) that quantitative and qualitative methods could not be mixed. Some of the founding explanations for the incompatibility thesis were the quantitative and qualitative differences in epistemological and philosophical considerations (Smith, 1983). The significant difference between the subject-object relationship required in quantitative research and the subject-subject relationship required in qualitative research was described by Smith (1983) as a difference too large to be able to mix methods and still be able to accomplish research. Smith (1983, p. 12) summarised “These positions do not seem to be compatible given our present

state of thinking. This is not to say that the two approaches can never be reconciled.” This position was refuted by researchers such as Greene, Caracelli, and Graham (1989) who presented 57 studies that had used mixed methods.

Reaching what seemed to be full circle, the argument for the compatibility thesis developed and the time from the 1990s until the present represents a period when quantitative and qualitative methods were acceptably used alone and by being mixed together (Tashakkori & Teddlie, 2003). This was largely based on the application of the philosophical paradigm of pragmatism to mixed methods which allowed researchers to continue to mix methods without sacrificing philosophical depth. Thus, the most significant changes that occurred throughout the 20th century to develop mixed methods were the labelling of this design as a new typology and the application of the philosophical assumptions of pragmatism. The use of mixed methods as a research design had continued throughout the 20th century but now it had a name and a description.

Mixed methods can contemporarily be defined as “The class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study” (Johnson & Onwuegbuzie, 2004, p. 17). Mixed methods combine the use of quantitative and qualitative research in an attempt to capitalise on strengths and avoid the weaknesses of the two prominent research methods (Creswell & Plano Clark, 2017). Utilising pragmatism, mixed methods are able to move from the inductive and deductive constraints of quantitative and qualitative design respectively and instead, design research that incorporates induction, deduction and abduction (Johnson & Onwuegbuzie, 2004). Abduction allows the researcher to move to and from induction and deduction, first converting observations into theories and then assessing those theories through action (Morgan, 2007). In this way, pragmatism allows for abductive-intersubjective-transferable aspects of research to be emphasised (Morgan, 2007). By avoiding the traditional limitations of research, mixed methods allow for researchers to be creative and follow their questions in the direction that will best provide an answer (Johnson & Onwuegbuzie, 2004).

Using mixed methods to conduct research allows for pluralism which informs researchers about epistemological and methodological possibilities that can enhance the effectiveness of research (Johnson & Onwuegbuzie, 2004). Rather than being constrained by the limits of one methodology, researchers are able to combine design components that will offer the

most effective way to answer a question. By utilising a needs-based approach to conducting research and not being constrained by the traditional methods used by either qualitative or quantitative methods, researchers are able to design a 'superior product' (Johnson & Onwuegbuzie, 2004). Howe (1988) suggested that truth is a normative concept, like good. Truth is what works. He said researchers should forge ahead with 'what works' (Howe, 1988) and using pragmatism and mixed methods allows for this.

Traditions of research within nursing have several implications for the development of a mixed methods project. Despite the long history of research in nursing, dating back to Nightingale in the 1860s, research in nursing is still considered relatively new compared to research in other disciplines (Twinn, 2003, p. 542). This may in part be due to the relatively new development of nursing as a profession. Nursing research may also have been relatively slow to develop as early nurse researchers were influenced by the need for their research to be accepted and respected by other scientific disciplines, the availability of funding and the publishing preference of available nursing journals (Twinn, 2003, p. 542). Because of these factors, early nursing research was largely influenced by quantitative methodology.

In the 1970s, a combination of the women's movement and a recognition of the complex social nature of nursing led nurse researchers towards qualitative methods (Twinn, 2003, p. 542). This began a paradigm conundrum within nursing. One answer to this qualitative versus quantitative problem was for nurses to begin designing mixed methods projects. This was perhaps opportune considering nurses work in a unique position where they must have an understanding of the theory that underpins their practice and clinical knowledge on which nursing intervention and procedures are based. There is such complexity in health care that researchers are increasingly recognising the need to study a number of perspectives when attempting to define practice (Sale, Lohfeld, & Brazil, 2002). There is a significant amount of past nursing research that has used a mixed methods approach and demonstrated the ability of mixed methods to address both the scientific and social aspects of nursing as a profession (Andrew & Halcomb, 2009).

Despite mixed methods being an accepted methodology in nursing research, it remains essential that these projects are designed correctly. Morgan (2007, p. 69) said "Research questions are not inherently important, and methods are not automatically appropriate". The purpose of mixed methods is to draw on the benefits of using the two traditional research designs. This is not automatically accomplished but rather is the result of a thorough

understanding of both methods and how to design a project that best utilises the strengths of each (Johnson & Onwuegbuzie, 2004). This creates a project that will work to the strengths of each method and offset, or at least decrease, the effect of each method's weakness. It is imperative that the two methods that are mixed are complementary and do not share similar weaknesses. This has been referred to as the fundamental principle of mixed methods research and involves recognition that all research methods have limitations and strengths (Brewer & Hunter, 1989; Tashakkori & Teddlie, 2003). Morse (2003, p. 195) believed that the major strength of mixed methods is that "they allow for research to develop as comprehensively and completely as possible". One major perceived weakness of mixed methods is that the method chosen to complement the primary design may be seen as shallow or incomplete (Morse, 2003). This is why it is important for mixed methods researchers to explicitly define their methods. Mixed methods researchers also need to consider the design of their project with reference to inference quality and inference transferability (Tashakkori & Teddlie, 2003).

Inference quality is a term in mixed methods that refers to credibility (qualitative definition) or internal validity (quantitative definition) (Tashakkori & Teddlie, 2003). Tashakkori and Teddlie (2003, p. 37) state that the presence of design quality and interpretive rigour is required in a mixed methods project to successfully claim inference quality. To achieve design quality, mixed methods research must incorporate all the components of design for the individual methods used in the study. This can be achieved by listing the essential components of both methods used in the project and ensuring each component is addressed. Achieving interpretive rigour is more difficult to accomplish and assess. Guba and Lincoln (1989) proposed five authenticity criteria (fairness, ontological authenticity, educative authenticity, catalytic authenticity and tactical authenticity) which are suggested by Tashakkori and Teddlie (2003) to address interpretive rigour. Although there remains no consensus on criteria for meeting interpretive rigour, it is important that this aspect of a mixed methods project is addressed. In recognition of these considerations, this research was based on the writings of mixed methods experts (Creswell & Plano Clark, 2017; Tashakkori & Teddlie, 2003) and the methods used in the project are explicitly defined in Chapter 4.

In addition to the requirement for design quality and interpretive rigour, researchers designing mixed methods projects should also consider inference transferability. This refers to the external validity (quantitative definition) or transferability (qualitative definition) of

the research (Tashakkori & Teddlie, 2003). Simply put, how will the results of the research project translate to the ‘real world’ environment? This issue will be discussed in Chapter 8. With consideration of the importance of choosing a correct mixed methods design, the next section will describe the researcher’s design decisions.

3.7.1 Choosing the Right ‘Mix’

The type of mixed methods used in this research project was chosen using the priority sequence model (Morgan, 1998) and principles of design for a mixed methods project (Morse, 2003). In 1998, Morgan developed a concept for choosing research designs based on the complementary assistance that is gained by mixing methods. The idea behind the concept was to divide the labour between the two methods by accounting for the strengths of each to address specific research questions. The priority sequence model is applied to determine which method will take principal status and which will be complementary. As was previously discussed, the aim of this project was to answer four research questions:

1. How many patients with an acute exacerbation of asthma were treated with NIV and what type of NIV was used?
2. Which hospitals and specialty areas used NIV to treat acute asthma?
3. Does NIV provide better clinical outcomes for patients with an acute exacerbation of asthma compared to standard medical treatment?
4. What are the experiences of nursing staff using NIV?

The first two research questions focus on exploring quantifiable data that will explain when and where NIV is being used to treat acute exacerbations of asthma. The third question requires biometric measurements to determine clinical outcomes of those patients compared to those who received only standard medical therapy. These questions are therefore quantitative in nature. They require the collection and analysis of quantifiable data to determine answers. The fourth question was formed to provide context to the first three questions. It is of little value in health for practitioners to be aware of the effects of a particular treatment if they are not also aware of the context of using that treatment. If NIV was determined to be an appropriate treatment for asthma but the results also indicated it was not being used in certain areas or for particular patients, then context is required to add depth to these issues. In this project, the strength of the quantitative phase is the ability for biometric data to be analysed to show the physiological effect of NIV on the human body. In doing so, the effect of this treatment and speed of patient recovery or decline can be

adequately defined. The primary fault of quantitative methods and the reason this project was designed with a qualitative component is that quantitative data are unable to explain context. The researcher is able to conclude whether NIV may or may not be a better treatment for acute asthma compared to standard medical therapy, but not the contextual effects of the location and staff on the utilisation of NIV itself. The research questions therefore necessitate a primarily quantitative study that can be followed up by qualitative inquiry to provide context. Figure 3.1 demonstrates the use of a principal quantitative method with complementary qualitative follow-up (Morgan, 1998, p. 368).

		Priority Decision	
		Principal Method: <i>Quantitative</i>	Principal Method: <i>Qualitative</i>
Sequence decision	Complementary Method: <i>Preliminary</i>	1. Qualitative Preliminary qual → QUANT Purposes: smaller qualitative study helps guide the data collection in a principally quantitative study	2. Quantitative Preliminary quant → QUAL Purposes: smaller quantitative study helps guide the data collection in a principally qualitative study
	Complementary Method: <i>Follow-up</i>	3. Qualitative Follow-up QUANT → qual Purposes: smaller qualitative study helps evaluate and interpret results from a principally quantitative study	4. Quantitative Follow-up QUAL → quant Purpose: smaller quantitative study helps evaluate and interpret results from a principally qualitative study

Figure 3.1 The priority sequence model
 Source/Note: Adapted from Morgan, 1998, p. 368

After the decision to design a mixed methods project that focuses on quantitative methods that are complemented by qualitative follow-up, there are other considerations for a mixed methods researcher. Morse (2003, pp. 194–195) described four major design principles required for a mixed methods project. These are:

1. Recognise the theoretical drive of the project
2. Recognise the role of the imported component of the project
3. Adhere to the methodological assumptions of the base method
4. Work with as few data sets as possible.

The primary theoretical drive for this research project was deductive as it sought to test the hypothesis that NIV is a better treatment for acute asthma than standard medical therapy. Deductive research is generally quantitative and therefore the quantitative phase of the project is the principal method and was allocated higher priority. It was also first in the sequence of methods. This was in recognition of the role the complementary component of the research would play. The purpose of complementing the quantitative phase of the project with a follow-up qualitative phase was to add depth of meaning to the quantitative data. During the design of this project it was also important to adhere to the methodological assumptions of the quantitative base of the project without compromising the assumptions of the qualitative phase.

Although the phases were designed together as part of one project, they were both designed with separate but complementary methodological assumptions. In regards to minimising the number of data sets utilised, this project was designed to include only one data set per phase. This was the smallest number of data sets that would be able to address the research questions. The quantitative data included numerical and categorical data that were used for statistical analysis. This was complemented by the qualitative data obtained by completing semi-structured interviews.

Morse (2003) designed a typology match to describe the unique way each mixed methods project combined the qualitative and quantitative components. The components of the typology match include the following:

- Use of the abbreviations QUAN for quantitative and QUAL for qualitative
- Use of the plus sign (+) to indicate that data are collected simultaneously
- Use of arrow (→) to indicate that data collection occurs sequentially
- Use of uppercase to denote the orientation that will receive more priority in the project.

The design of this project written using Morse's typology match would therefore be:

QUAN → qual

which denotes that the quantitative phase of the project is conducted first and has greater priority and is followed sequentially by the qualitative phase. Morse's (2003) explanation for the use of a QUAN → qual design describes two separate projects being undertaken and integrated at points within the project. The first phase of the project uses a quantitative sample, the second a purposive qualitative sample. The quantitative phase is generally completed prior to the initiation of the qualitative phase and the results are triangulated by

using the results of the qualitative phase to provide an explanation for certain parts of the quantitative phase (Morse, 2003, p. 205). The exact methods used to conduct both the quantitative and qualitative phases of this research project are explained in Chapter 4.

3.8 Positionality

Positionality refers to an individual's world view and the position they have chosen to adopt in regards to a specific research task (Foote & Bartell, 2011; Savin-Baden & Major, 2013). The importance of proclaiming positionality is to recognise that the values, beliefs and experiences of a researcher affect the way they conduct research (Foote & Bartell, 2011). As Hammersley and Atkinson (1995, p. 17) professed "There is no way we can escape the social world to study it". The pragmatic view also recognises the researcher is a part of and influenced by what they study.

In this instance, the researcher is in agreement with the ontological and epistemological assumptions associated with Deweyan pragmatism as have been discussed. This perhaps served as an influence on the adoption of these particular philosophical assumptions as a basis for this research project. Ontologically, this research is based on the assumption that things exist as they are experienced, but also exist independently of that experience. Multiple truths are present in the world. Epistemologically, knowledge is acquired through practice and the value of a theory or idea is measured by its ability to perform the task for which it was intended. The positionality of the researcher is also defined by the values and beliefs that may have an effect or influence on the conduct of the project and subsequent analysis. It is important the position of the researcher is defined in relation to the subject, the participants and the research content (Herod, 1999).

The researcher undertaking this project is a critical care nurse who has worked in regional ICUs for the past six years. Due to this, the researcher has spent an extensive period of time using NIV to treat patients with acute respiratory failure including those with acute asthma. Due to her background of living and working in small rural and regional facilities, the researcher has a particular interest in the contextual effects of these environments. As a nurse, the researcher is also privy to the unique power relations within the profession and the means by which it is governed. At the time data collection was undertaken, the researcher was employed in one of the facilities in which quantitative data were collected. She also worked alongside several of the nurses who were interviewed. Only two of the nurses who

were interviewed were unknown to the researcher at the time the interviews were conducted. Being a colleague and in some cases a friend of the participants, the researcher valued their opinions and experiences and felt it important that the stories of the nurses were told.

3.9 Chapter Summary

This chapter has outlined the philosophical assumptions of Deweyan pragmatism that were used in the design of this mixed methods project. The main philosophical assumptions identified were: the existence of multiple truths, the importance of perception in relation to what is real, the fallibilism of knowledge, rejection of scepticism, the influence of context on experience, the value of ideas as tools for inquiry and the proposition that knowledge is an instrument. The assumption of naturalism associated with Dewey required examination of its ability to coincide with the anti-naturalistic view of phenomenology. This issue was resolved by drawing on previous work on the process of naturalising phenomenology and accepting that external and experiential information are equally important and each may contribute to this inquiry. Moving from the philosophical assumptions of the project, the methodology was discussed in relation to its congruence with the paradigm of pragmatism and its ability to answer the questions posed in this research. Finally, the position of the researcher in relation to the project was described to enable readers to understand the context in which the project was based. The following chapter will extend from the current discussion and describe the methods employed in this project to undertake the process of data collection and analysis.

Chapter 4: Methods

4.1 Introduction

The purpose of this chapter is to describe and discuss the methods that were used to complete this research project. The project employed a mixed methods approach, specifically, a sequential explanatory design in which the researcher conducted quantitative data collection and analysis then used those results to design and conduct a qualitative data collection and analysis phase. The process of data collection and analysis in both the quantitative and qualitative phases is detailed and the method by which the two separate phases were integrated at various points in the project is outlined. The quantitative phase was a retrospective cohort study structured by the characteristics required to satisfy the objectives of this method. The qualitative phase was underpinned by the methods utilised in phenomenology. The two phases met at two points within the project and illustrated the ability of the individual methods to complement one another to allow for a broad view of the phenomenon under study.

4.2 Sequential Explanatory Design

This mixed methods project utilised a sequential explanatory design as described by Creswell and Plano Clark (2017) and Ivankova et al. (2006). The basic premise is that the research project is conducted in two distinct phases, quantitative and qualitative, which are integrated at specified points in the project (Ivankova et al., 2006). The principal quantitative phase is conducted first and followed sequentially by a separate qualitative phase. The quantitative and qualitative data are analysed separately (Creswell, 2014). The sequential explanatory design used in this project ensured the two phases were connected at the selection of participants for the qualitative phase and when developing the protocols and questions for the qualitative phase. The outcomes of both phases of the study were then integrated in the discussion. This allowed the discussion to use both sets of results to answer the research questions fully (Ivankova et al., 2006).

Figure 4.1 shows the six steps used in the sequential explanatory design of this project. First, the quantitative data were collected retrospectively from medical records; this included numerical and categorical data. The data were then analysed using Fisher's Exact test, Chi-squared tests and linear mixed models. In Step 3 the results from the quantitative data analysis

were used to define a sample and design questions for the qualitative phase. Qualitative data collection was conducted using semi-structured interviews. The interviews were transcribed and analysed in Step 5. The final component of the sequential explanatory design was the integration of both phases of the results to examine the findings together.

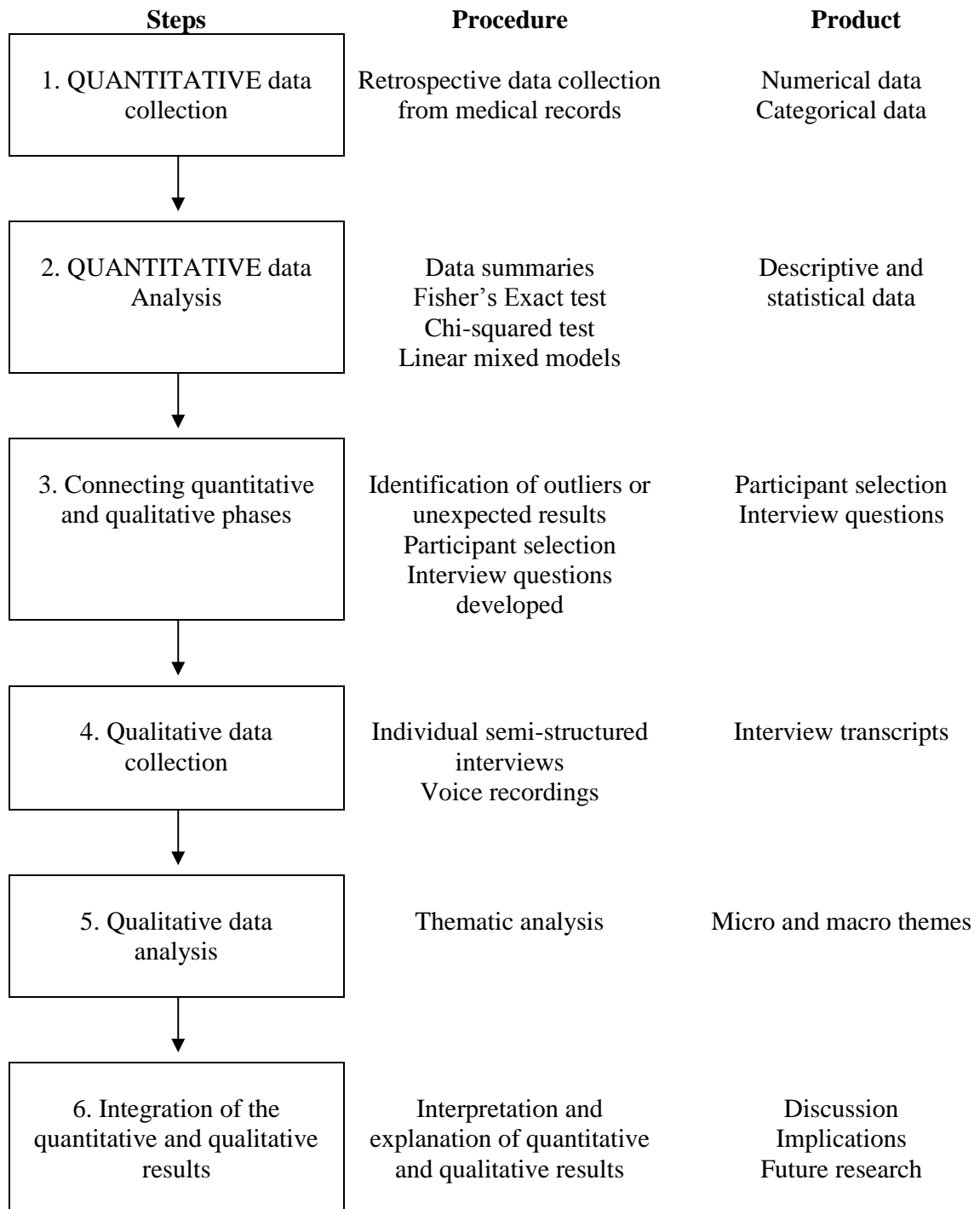


Figure 4.1 Visual model for mixed methods sequential explanatory design procedure
Source/Note: Creswell & Plano Clark, 2017, p. 122

4.3 Step 1: Quantitative Data Collection

One of the challenges for mixed methods researchers is to ensure that the components required to conduct rigorous quantitative and qualitative research are maintained. The quantitative data collection techniques utilised in mixed methods research must adhere to the criteria required for a quantitative project alone (Creswell & Plano Clark, 2017). A retrospective cohort design was chosen for use in this project for two reasons. Firstly, the body of evidence indicating the possible benefit of using NIV to treat asthma would render a RCT unethical (Song & Chung, 2010). Secondly, severe asthma requiring ICU admission is relatively rare, making it more viable to look retrospectively at admissions rather than conduct a RCT requiring prospective enrolment (Mann, 2003). The criteria required to conduct a rigorous retrospective cohort study were considered in the design of this project.

Song and Chung (2010, p. 2238) state that the primary requirement of a retrospective cohort study is “defining the selected group of subjects by exposure status at the start of the investigation”. The two groups being studied must be chosen from the same source population (Song & Chung, 2010). The population of interest in this project was adult patients presenting to an ED in the MLHD with severe asthma. The treatment of interest was NIV and therefore the population was only inclusive of patients who had presented to an ED with severe asthma after 2010 as this was when NIV was largely implemented in hospitals across the MLHD. Data were also collected only from the nine hospitals using NIV as an available treatment. Criteria for inclusion and exclusion in this study will be discussed more thoroughly below. As this research project collected data from the whole population of interest, there were no requirements for sampling or to conduct power analysis.

A retrospective cohort study uses data already collected (usually for another purpose) to compare the group who received the treatment (in this instance NIV) to the group who did not receive the treatment (Elwood, 2007, p. 24). Once the groups are divided into those who were exposed or not exposed to the treatment “the remaining factor to be assessed is the outcome” (Elwood, 2007, p. 123). In this study, there were several outcomes of interest, one of which was the efficacy of the NIV in treating acute respiratory failure within the first four and 18 hours (to show short- and medium-term effects). Defining measures of acute respiratory failure was therefore essential in determining these outcomes.

Arterial blood gases are important in the diagnosis of acute respiratory failure and assist to identify the severity of an asthma attack (Tuxen & Naughton, 2009, p. 401). Changes in severe asthma seen in arterial blood gases may include hypercapnia (increased pCO₂) and acidosis indicating the asthma is severe. Whilst hypoxaemia is a general indicator of respiratory failure, its use is limited when patients receive oxygen therapy and therefore the results of the arterial blood analysis of interest for this study were the pH (potential of hydrogen) and pCO₂. The patient's respiratory rate was also taken into consideration due to respiratory rate ≥ 30 breaths per minute generally being indicative of severe asthma (Tuxen & Naughton, 2009, p. 400). Respiratory rate is recorded for every patient admitted with respiratory failure, however, it is not compulsory to collect arterial blood gases. In the instance where there was no arterial blood gas on which to assess the severity of a patient's asthma, the admitting physician's notes were consulted for documentation of asthma that was 'severe', 'extremis' or patient able to speak in 'single words only' (rather than sentences), all of which indicate severe asthma (Tuxen & Naughton, 2009, p. 401). The other primary outcomes of interest were ICU and hospital length of stay and survival to discharge. These measures are all recorded as part of routine hospital data and were identified using the patients' medical records.

Potential sources of bias were also considered in the study design. Collecting data from medical records removed the risk of observer bias but there was still a possibility for outcome bias. To address this, the data chosen for collection were strictly objective, reproducible and robust. Biometric measures such as a patient's pH and pCO₂ are calculated by biomedical devices independent of clinicians. A patient's respiratory rate is calculated by counting the number of times a patient takes a breath in one minute (Johns Hopkins Medicine, n.d.). A patient's length of stay in any inpatient unit or hospital is an objective measure of time and survival to discharge is definitive. The outcome measures used in this research project had very limited opportunity to be influenced by variations in the methods of testing (Elwood, 2007, p. 130). It should also be noted that the retrospective nature of this study ensured that none of the patients or healthcare staff were aware that the data being collected would be involved in a study.

Another reason for selecting retrospective data collection from medical records as the data collection method was its simplicity and ability to collect large amounts of data in a timely fashion (Mann, 2003). The researcher was also aware from her work as a RN that the data

required to answer the research question were available in patients' medical records. In this project, quantitative data collection was conducted in several steps, as depicted in Figure 4.2.

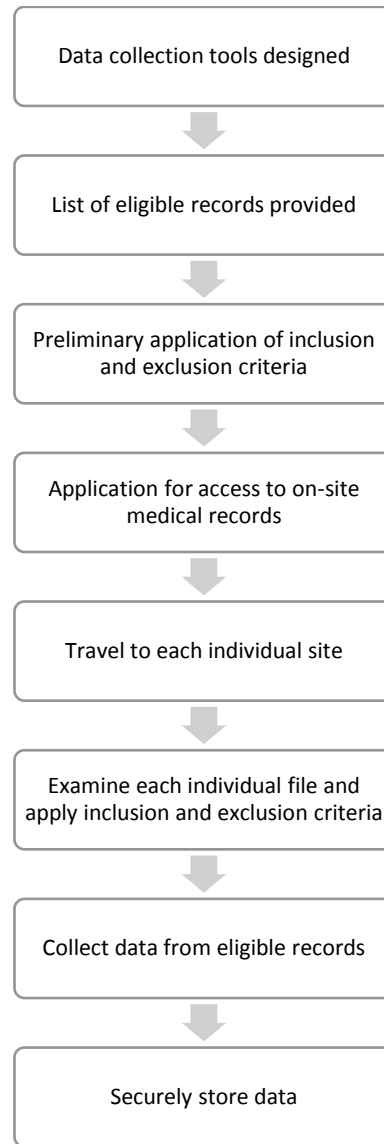


Figure 4.2 Quantitative data collection steps

The population of interest was defined by the researcher as above then identified by the Area Data Coordinator who was responsible for the data collected from all hospitals across the MLHD. A list of medical record numbers of patients who had presented to one of the nine EDs and were coded for asthma was sent to the researcher by the Area Data Coordinator. This list also had information including site of admission, date of admission and age of patient at time of admission. Using the age criterion, the researcher excluded all patients who were not ≥ 18 years at the time of their presentation. The electronic medical records of every

presentation on the list were examined to determine which patients met the inclusion and exclusion criteria for the study.

All patients who met the inclusion criteria or could not be excluded due to the absence of electronic medical records or lack of available data were listed according to site. The researcher then applied for access to the paper-based medical records of each of the patients remaining on the list from the nine sites. This required negotiation for availability of the hospital and the researcher and the ability of staff to locate the medical records. In one small site, there was no administrator employed so the researcher was shown by hospital staff how to locate medical records. In all other sites the medical records were located for the researcher. When on-site, the researcher was allocated a room and did not leave the hospital grounds during data collection.

Retrospective data were collected from medical records for individual presentations that fitted the inclusion and exclusion criteria as outlined in Figure 4.3. It took between one day and several weeks to collect all of the available data from each site. The purpose of the inclusion and exclusion criteria was to ‘capture’ patients who would have been eligible for treatment with NIV as stipulated by the MLHD procedure for NIV (adult) (Green & Haworth, 2015). The inclusion and exclusion criteria were complicated by the variability in admissions, particularly when comparing the regional and rural facilities. For example, in some rural facilities the emergency physician was also the local general practitioner (GP) who could have admitted patients directly into a ward bed rather than through the ED. Some of these patients were still eligible for inclusion in the study so the researcher had to stipulate a time period after which they would be excluded and deemed an inpatient. Four hours was chosen as the time period as this was what NSW Health stipulated was the maximum period of time in which patients should be located in an ED (NSW Ministry of Health, 2012).

Another complication encountered when collecting retrospective data from medical records was the variability in type of data recorded by the healthcare practitioners. Some of the sites collected blood samples, most recorded a full set of observations including heart rate, respiratory rate and oxygen saturations, and some relied on the assessment made by the treating physician which was documented differently according to the individual. For the researcher to work with the differing data sets and still ‘capture’ all patients who were eligible for treatment with NIV, two combinations of the MLHD procedure’s inclusion criteria were identified and are illustrated in Figure 4.3. The exclusion criteria remained

applicable to all sites and therefore were included from the MLHD procedure for NIV without alteration (Green & Haworth, 2015).

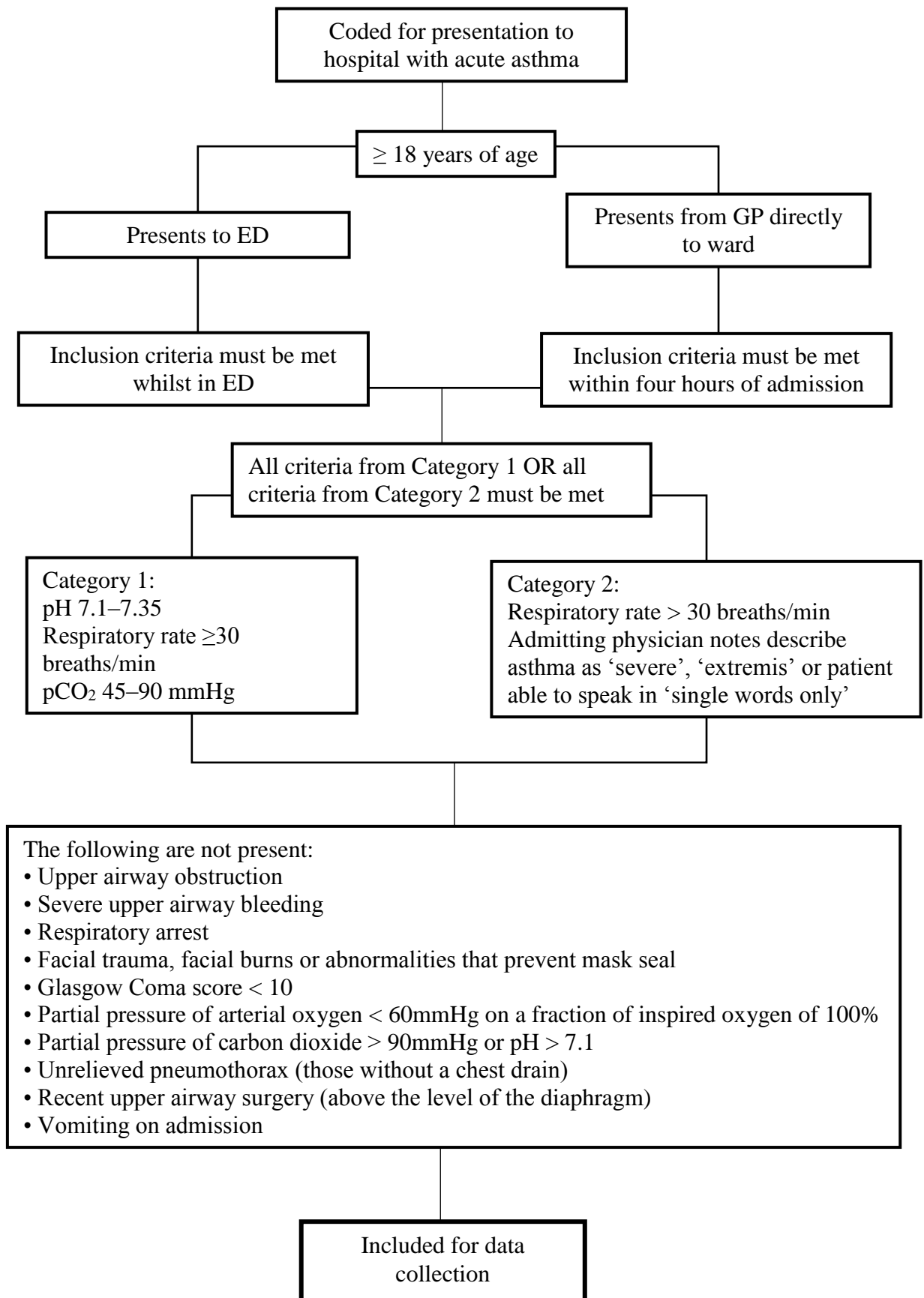


Figure 4.3 Inclusion and exclusion criteria flow chart used for retrospective data collection from medical records

Once an individual admission was determined eligible for inclusion the researcher began to collect data from the medical record for that individual admission. The categorical and numerical data that were collected are outlined in Table 4.1. The data were divided into re-identifiable and de-identified data for collection and storage. The first set of data included the patient's medical record number, date of admission and hospital of admission and was considered re-identifiable data. This was stored as an Excel spreadsheet on a password-locked computer.

The second component of the retrospective data collected from medical records was de-identified data. This was completed using a survey designed on SurveyMonkey with the assistance of the Spatial Data Analysis Network at Charles Sturt University. Data were collected using the data collection tool to improve consistency and timeliness. Data collection tools are considered important for rigour when designing quantitative research as they allow the same data set to be collected for each sample. The survey used in this project was designed with limitations set on answers so that the likelihood of entering inaccurate numbers was decreased. For example, when entering a patient's heart rate, the researcher was unable to enter numbers outside of 30–200 beats/min as these patients would have been considered haemodynamically unstable and therefore fall within the exclusion criteria for this study. The two data sets were coded so they could be combined at the conclusion of data collection and following this the medical record numbers were removed.

Table 4.1 Categorical and numerical data collected retrospectively from medical records

Demographic data	Age (years) Sex (male/female)
Confounders	Comorbidities (list) Complications of NIV (list) Acute Physiological and Chronic Health Evaluation II score (0–299) Intubation (yes/no) Development of ventilator-associated pneumonia (yes/no) Heart rate Mean arterial pressure Oxygen saturation
Treatment variables	Location of NIV treatment Hospital of admission Inter-hospital transfer Hospital of discharge Need for intravenous bronchodilators Hours from admission to NIV commencement NIV hours Invasive ventilation (hours) Spirometry (yes/no)
Primary outcome measures	pH pCO ₂ Respiratory rate Hospital length of stay (hours) ICU length of stay (days) Survival to discharge

4.4 Step 2: Quantitative Data Analysis

Once all quantitative data were collected it was organised for analysis. The data collected using the SurveyMonkey tool were exported from the surveys into an Excel spreadsheet. These data were then combined with the re-identifiable data collected in the separate Excel sheet. Once the data were collated into the Excel sheet it was ‘cleaned’ by the researcher. This involved tasks such as:

- removing obsolete columns
- checking all blank columns and entering not applicable (NA)
- checking numerical columns for any obvious errors
- ensuring spelling/grammar was universal for the same value
- calculating patient age at time of admission from their date of birth then removing the date of birth column and replacing it with age
- reassigning hospital names with codes i.e. Hospital A, Hospital B

- reassigning hospital sizes to codes i.e. small (< 50 beds), medium (50–200 beds) and large (> 200 beds) and
- removing patients' medical record numbers.

The organisation and 'cleaning' of data were important steps before analysis so that the researcher could ensure there was no missing or misspelt data. It also gave the researcher an opportunity to have a preliminary look at the data and identify any obvious errors. The research co-supervisor also checked the data to identify any errors or missing data. After the data were 'cleaned', they were analysed in two phases. The first phase was conducted by the researcher. Data were organised into descriptive statistics to define age, sex, hospital of admission, hospital of discharge, comorbidities, spirometry use in the ED and type of NIV used during treatment. This phase was also used to view the data for any obvious outliers or unexplained results. The first two research questions were then addressed. Bar graphs were used to demonstrate which hospitals and specialty areas had used NIV to treat acute asthma and the number of patients with an acute exacerbation of asthma treated with NIV between 2010 and 2015. The researcher also used a Chi-squared test and Fisher's Exact tests to determine if there were relationships between different variables.

A Chi-squared test is a "nonparametric test used to assess whether a statistically significant association exists between the rows and columns in a cross-tabulation table" (Plichta, Kelvin, & Munro, 2013, p. 456). The assumptions of a Chi-squared test are that the data are frequency data, there is an adequate sample size and the measures are independent of each other (Plichta et al., 2013, p. 295). This test compares the expected frequencies with the observed frequencies in each cell to determine the extent to which they differ. If the differences are large enough to generate a Chi-squared value that exceeds the critical value, the null hypothesis is rejected and it can be stated that the relationship between the two variables is statistically significant (Plichta et al., 2013, p. 296). The Chi-squared test was used in this project to determine if there was a relationship between a patient's sex and if they received NIV as a treatment.

Fisher's Exact test is similar to the Chi-squared test except it does not require that all values are greater than five. In the instance that there are values less than five, the Chi-square distribution is not a suitable approximation. Fisher's Exact test is used in this instance because it provides an exact *p*-value and does not require an approximation technique (Triola

& Triola, 2006). Fisher's Exact test was used to test if the number of hospital presentations with severe asthma was related to year, individual hospitals or size of hospital of admission. This test was also used to determine if there was a relationship between the use of NIV and the hospital of presentation.

The third research question: 'Does NIV provide better clinical outcomes for patients with an acute exacerbation of asthma compared to standard medical treatment?' required several statistical tests. Firstly, the researcher collated the types and amounts of standard medical therapy given to both the group who received NIV and the group who did not receive NIV. Fisher's Exact test was used to determine if there were differences in the types of standard medical therapy received by each group. The researcher then consulted with a statistician who used linear mixed models to examine the effect of NIV and time on pH, pCO₂ and respiratory rate whilst accounting for several other covariates.

A linear mixed model is defined by the response, a fixed model and a random model (Welham, Gezan, Clark, & Mead, 2015, p. 428). They are a class of statistical analysis that extend multi-stratum analysis of variance to the cases of unbalanced and non-independent structures (Welham et al., 2015, p. 427). They also extend regression models to include a structural component (Welham et al., 2015, p. 427). Structure is often present in observational studies such as this project and must be accounted for in the statistical analysis of the data. In this project, data were collected from several of the same patients during different admissions. Although the individual presentations are the point of interest, there will inevitably be systematic differences between the individual patients which will apply to the data sets collected. Incorporating the structure of the observations ensures that explanatory terms are compared to background variation in the correct level or stratum (Welham et al., 2015, pp. 427–428).

The linear mixed models were conducted in ASReml in R (Butler, 2009). Response variables tested included pH, pCO₂ and respiratory rate. These biometric measures were chosen as they are representative of a patient's respiratory status and are a rapid feedback system for changes in a patient's condition (Tuxen & Naughton, 2009). These measures are also routinely documented for inpatients with acute respiratory distress which decreases the likelihood of missing data. The fixed effects used in the linear mixed model were NIV and time. NIV referred to whether or not a patient received this treatment. Time was recorded at zero, four and 18 hours after meeting the inclusion criteria to represent the patient's baseline,

short- and medium-term status. Random terms fitted in the model were hospital, patient and the interaction of hospital and patient. These were examined with the interaction of several explanatory variables. Explanatory variables are variables which may have an influence on or explain the response variables (Triola & Triola, 2006, p. 449). Each explanatory variable is shown in Table 4.2 with an explanation for inclusion.

Table 4.2 Explanatory variables and reasons for inclusion in quantitative data analysis

Explanatory variables	Reasons for inclusion in analysis
Size of hospital	The classification of a hospital as small, medium or large will influence resources and may affect treatment.
Age	The age of a patient at time of admission may affect treatment due to increasing severity of illness and comorbidities.
Sex	Patient's sex may have an influence on the type of treatment they receive.
COPD	A diagnosis of COPD is likely to affect the severity of respiratory symptoms.
Current smoking	Current smoking may increase the severity of an asthma attack.
Allergies	Allergies are documented as more likely to be present in patients with more severe asthma. They may also complicate treatment.
Spirometry	The use of spirometry assists the diagnosis of acute asthma and the treatment.
Hours from admission to NIV commencement	Patients who have delayed treatment may have poorer outcomes.
Total NIV hours	Increased time period on NIV as a treatment may be related to the severity of the asthma attack.
Need for intubation	The need for intubation is a reflection of both available resources and the severity of an asthma attack.
Intubated on day number (i.e. the day of hospital stay on which the patient was intubated)	Delayed intubation can be the result of resource availability and response to treatment and may influence outcomes.
Invasive ventilation hours	Increasing time period on mechanical ventilation increases risk of adverse effects and poorer outcomes.
ICU	The requirement of admission to ICU can reflect the severity of asthma.
ICU length of stay	Length of stay is a reflection of hospital resources and severity of the asthma attack.
Hospital length of stay	Longer hospital length of stay increases patient risk of adverse effects and may be a reflection of the severity of illness or presence of comorbidities.
Inter-hospital transfer	The need for transfer to an alternative facility may be a reflection of resource availability in the location of presentation or the severity of the asthma attack.

During the analysis undertaken to answer the third research question, the model assumptions for the linear mixed model were that the residuals were normally distributed, they had a constant variance and were independent (Rencher & Schaalje, 2008, p. 501). The assumptions were checked using residual plots and the Shapiro-Wilk test of normality. Additionally, the factor level variances were tested to determine if they were equal for both treatments using the Brown-Forsythe test. Any analysis that included unequal variances were analysed using a weighted least squares analysis to account for the different variances associated with the different groups. All model assumptions were met unless otherwise stated. In all analyses, a 5% significance level was used. This denotes the probability of rejecting the null hypothesis when in fact it is true (Welham et al., 2015, p. 30). In all instances, the use of A:B represents the interaction of A and B. Where relevant, the standard error of each mean has been provided. Standard error represents the level of uncertainty associated with a value due to variability in the sampling process and measurements themselves (Welham et al., 2015, p. 8). It is calculated by dividing the sample standard deviation by the square root of the sample size (Welham et al., 2015, p. 30). Where predicted values have been presented, so too has the standard error of prediction. The results of the quantitative phase of this project can be found in Chapter 5.

4.5 Step 3: Connecting the Quantitative and Qualitative Phases

Integrating the quantitative and qualitative phases is imperative in mixed methods research (Creswell & Plano Clark, 2017). As suggested by Creswell (2014) in his explanation of a sequential explanatory mixed methods design, the quantitative and qualitative phases were integrated at two points in the project. The first integration of the methods was conducted in Step 3. Once the quantitative data had been analysed, outliers, differences and similarities were identified for further investigation using the qualitative interviews. In this project, there were several areas identified by the quantitative data that were unexplained or occurred in contradiction to clinical guidelines. In this step, the results of the quantitative data analysis were used to design the questions and choose the sample group for the qualitative phase. The qualitative questions were designed to illicit explanations and insights into these phenomena.

4.6 Step 4: Qualitative Data Collection

The qualitative phase of this research project was guided by phenomenology. This is because the research aimed to explore the lived experiences of the nurses and the meaning of the

experiences to those nurses (Polit & Beck, 2017). More specifically, this project was guided by the phenomenology of practice, described by van Manen (2014, p. 15) as a “kind of inquiry that addresses and serves the practices of professional practitioners as well as the quotidian practices of everyday life”. Phenomenology is inherently not a written set of methods but rather a broad approach to inquiry. It will be discussed in this manner with the actions of the researcher broadly classified as empirical phenomenological methods and reflective phenomenological methods. The empirical phenomenological methods such as recruitment and interviewing represent the qualitative data collection phase and will now be discussed.

4.6.1 Recruitment

The qualitative phase of the research project utilised a purposive sampling technique and included nurses working in EDs, HDUs and ICUs in the nine sites from which quantitative data were collected. Participants were recruited using a combination of techniques. First, they were informed of the study by a generic email sent to all eligible nurses that outlined the study information and researcher contact details. During the quantitative phase of data collection while the researcher was on site, eligible departments were visited and the researcher personally gave information to groups of nurses about the requirements of the study. During site visits, the researcher also put flyer advertisements on the noticeboards in staff rooms with the permission of the nurse managers. Participants were targeted on the basis they were RNs working in EDs, HDUs or ICUs in the nine hospitals from which the quantitative data were collected (i.e. those using NIV). The purpose of this targeted recruitment was to capture a group of nurses who had experience using NIV and thus had lived experiences they could describe.

4.6.2 Semi-structured Interviews

The main purpose of empirical qualitative methods is to explore examples and varieties of lived experiences. The types of experiences phenomenology is concerned with are prereflective experiences – that is, experiences as they happen and before they are reflected upon (van Manen, 2014, p. 28). Unfortunately, it is impossible to capture an experience as it is lived because as soon as an experience is looked upon it is no longer prereflective. Researchers instead must focus on the original experiences of participants and the meanings those experiences have. These experiences can be shared during semi-structured interviews. Semi-structured interviews provide a balance of informal conversational interview and open-

ended interview techniques (Serry & Liamputtong, 2017). This gives the researcher the opportunity to both explore themes and issues as they arise but also have specific questions answered. Semi-structured interview questions were developed for this project using the results of the quantitative data analysis with the purpose of enriching the quantitative results. As has been suggested by Creswell and Plano Clark (2017), some key quantitative results that can be further explored qualitatively include both statistically significant results and nonsignificant results, key significant predictors, outliers or extreme cases and distinguishing demographic characteristics.

Phenomenology means "... to let that which shows itself be seen from itself in the very way in which it shows itself from itself" (Heidegger, 1962, p. 58). It relies on participants sharing experiences and meaning with the researcher. Therein lie practical issues such as the difficulty some people encounter when attempting to share experiences rather than just providing an account or recall, followed by the difficulty of capturing those experiences as they are shared (van Manen, 2014, p. 53). In recognition of this, the researcher explained to the participants the primary intention of the research was to hear their experiences and stories. It was deemed important that the interview participants felt comfortable during the interview process to facilitate this sharing. Each interview was conducted at a location of the participant's choosing within the hospital in which they were currently employed. Each individual interview was conducted by the principal researcher. The locations were sheltered from public view and generally provided an uninterrupted setting for the researcher and participant.

As previously described, the initial interview questions arose from the quantitative results and analysis. The questions did change across the course of the interviews in response to the path taken by the participants. In this way the participants were able to lead the data collection and the researcher was responsive to the data. All interviews were centred on eight broad categories in which the researcher asked set questions and then allowed the participant to lead the conversation. The categories covered are shown in Table 4.3.

Table 4.3 Categories of questions asked in semi-structured interviews

Broad categories	Examples of questions asked
Introduction to NIV	How were you introduced to NIV? How did the way you were introduced to NIV make you feel? Do you think it could have been done differently?
Broad experiences	What have your experiences been like when using NIV? Have you had any particularly good or bad experiences? Are you comfortable using NIV? Why/why not?
Influences on the nurses' ability to use NIV	Are there any particular factors that influence or inhibit your use of NIV? Discussion of influences such as team, skill mix and shifts.
Clinical experiences	What diagnoses do you commonly use NIV for? Are you more comfortable to use NIV on a patient a second time? How do you determine if your patient is getting better or worse?
Educational experiences	How did you learn to use NIV? Do you receive ongoing support to improve your education in NIV? How do you feel about self-initiating education?*
Experiences with NIV on the wards	Do you ever treat patients on the wards with NIV? Do you think patients on NIV should be treated on the wards?
Frequency of use	How often do you think you would use NIV on average in one year?
Clinical responsibility	Who makes the decision to treat a patient with NIV? Is the decision to use NIV based on guidelines?*** Who changes the settings? Are doctors responsive to being questioned by nurses?
*Questions added for Participant 5 onwards	
**Question added for Participant 6 onwards	

4.6.3 Reflection

Reflective methods are imperative in phenomenological research (van Manen, 2014). In this project, reflective methods played a significant role in the qualitative data analysis. Before thematic analysis began, reflective methods were also used in the qualitative data collection process. The interviewer reflected on every interview in the immediate period afterwards and before another interview was commenced. This allowed the researcher to gain an evolving understanding of the content of the individual interviews as well as a broad view across all the interviews. Reflection was also undertaken by the researcher during supervisory sessions with the research principal supervisor. The reflection process facilitated fluidity of the research questions and the ability of the researcher to follow the direction of

the data. Table 4.3 illustrates this as three baseline questions were added to the interviews during the qualitative data collection phase. This was a result of the researcher reflecting on what the participants were saying.

4.6.4 Transcription

All interviews were voice recorded by the researcher and stored as electronic recordings on a password-protected computer until the time of transcription. The files were sent via Dropbox to a transcriber who created a draft version of the interviews as text. The researcher then went through each interview and transcript individually to create the final versions of the transcribed interviews. The recordings were each listened to multiple times by the researcher to edit the transcriptions and ensure they were a correct reflection of the interviews. Listening to the interviews further enabled the researcher to reflect on the conversation had with the participants. Through this process the researcher became immersed in the data and intimately familiar with the transcripts of the interviews.

4.6.5 Validity

Creswell (2014, p. 201) discusses the importance of trustworthiness, authenticity and credibility when reporting the findings of qualitative data and suggests it is important for the researcher to use several methods to ensure the data presented are accurate from the standpoint of the researcher and participants. Some of the methods to ensure validity suggested by Creswell (2014, p. 201) were utilised in this research project. Firstly, a clarification of the bias the researcher brings to the study is presented in Chapter 6 alongside the qualitative findings. As Creswell points out “This self-reflection creates an open and honest narrative that will resonate well with the readers” (2014, p. 202). In addition to divulging personal bias, the researcher also includes a reflection of how the findings may have been shaped by her gender, culture, history and socioeconomic background.

A second method suggested by Creswell (2014, p. 202) to contribute to the validity of qualitative findings is for the researcher to spend a significant amount of time in the field. Creswell (2014) believes this allows the researcher to develop an in-depth understanding of the phenomenon under study and is therefore able to contribute more detail about the people and places in which the phenomenon takes place. Creswell (2014, p. 202) feels that “the more experience that a researcher has with participants in their settings, the more accurate or valid will be the findings”. has spent approximately five years working in the field of

critical care nursing which was the area of focus for this study. The researcher is employed alongside many of the participants and has worked in the same or similar locations.

Validity is also achieved by the researcher presenting all relevant information even if it does not fit within the themes of the data or presents a different viewpoint. Creswell (2014, p. 202) states that this is important because it is an accurate reflection of life and the inevitable fact that people have differing perspectives and experiences. Creswell (2014) suggests that the researcher can contribute to the validity of the research findings by presenting not only the evidence for a theme but also the evidence that is contradictory or opposing to the theme described. This aspect of validity was considered in the presentation of the research findings and the researcher remained open to presenting themes as discussed by participants regardless of the interaction of the data.

4.7 Step 5: Qualitative Data Analysis

4.7.1 Epoché-reduction

Epoché and reduction are two fundamental components of phenomenological data analysis (van Manen, 2014). Husserl described phenomenology as a pure science, one stripped of all empirical content (Moran, 2000, p. 133). To allow for purity, he employed the methods of epoché and reduction. That is, Husserl recognised that phenomenological description was hindered by the inherent human tendency to interpret, to apply everyday preconceptions and practical interests to a pure experience. He used epoché and reduction to remove these inherent tendencies and gain access to raw experience. Van Manen (2014, p. 215) described epoché and reduction as “the great finds of Husserl’s phenomenology” in his discussion of phenomenology of practice.

The epoché can be defined as “The first of the phenomenological reductions, whereby consciousness abstains from judging (positing) or assuming the existent status of the objects with which it is involved” (Kleinberg-Levin, 1970, p. 24). The use of epoché was important for the analysis of the qualitative data due to the researcher coming from a position embedded in the phenomenon under study. Van Manen (1997, p. 46) has previously stated that “The problem of phenomenological inquiry is not always that we know too little about the phenomenon we wish to investigate, but that we know too much”. This statement resonates with this project as the researcher is a nurse and has worked in many of the facilities included in this study and alongside several of the participants. This risks the

researcher making presumptions about the study findings without allowing them to speak for themselves. Husserl's answer to this was to suggest a method of bracketing in which the researcher separates a phenomenon from their previous knowledge and experience (Kleinberg-Levin, 1970, pp. 24–25). The problem with this method, as suggested by van Manen (1997, p. 47), is that it is impossible to remove from our minds what we already know or have experienced. It is instead “better to make explicit our understandings, beliefs, biases, assumptions, presuppositions, and theories” (van Manen, 1997, p. 47). The importance of identifying previous assumptions about a phenomenon is not so the researcher can forget them, but so the researcher is able to recognise the effect of previous experience on the research. The positionality of the researcher can be found in Chapter 3. The epoché allowed for a full view of the phenomenon without an attempt to categorise that phenomenon, particularly as the experiences of participants illuminated practices and relationships that were contrary to the account hospitals and professionals would present of themselves.

At the same time as the epoché occurs, so too does the reduction. This is the step where the researcher is able to openly regard the phenomenon under study. As described by Husserl “even if these data are related to objective actuality via their intentions, their intrinsic character is within them; nothing is assumed concerning the existence or non-existence of actuality” (as cited in Moran 2000, p. 150). The words used by the participants in every instance were allowed individual existence and were examined with pre-consciousness, what Husserl (1931, p. 11) called ‘transcendental subjectivity’. Utilising this method, everything the participants expressed was accepted and understood uniquely and alone. The entire purpose of the epoché-reduction is to “make contact with experience as it is lived” (van Manen, 2014, p. 222).

4.7.2 The Reduction Proper

Van Manen (2014, p. 228) refers to epoché-reduction as a form of preparation of the researcher before the reduction-proper. Eidetic reduction was used as the reduction proper in this project and has been described by both Husserl (1931) and van Manen (2014, p. 228). This method “... seeks to describe *what* shows itself in experience and *how* something shows itself ... [it] ... focuses on what is distinct or unique in a phenomenon” (van Manen, p. 228). In this project, the phenomenon of interest was the use of NIV but the experience of interest was that of the nurses using this treatment. This distinction is important to note so it is clear that the results of the qualitative analysis pertain to nurses' experiences of NIV, not NIV

itself (Paley, 1997, p. 189). Once the epoché-reduction has been undertaken the researcher is left with original consciousness which allows only description of experience without judgement during the reduction proper (Paley, 1997, p. 190). At this point the experience of the nurses was described and free variation used to determine the aspects of their story that were essential to the concept they had presented. The combination of themes made the experience what it was for the nurses.

4.7.3 Thematic Reflection

Themes initially emerged as micro themes knitted across the transcripts and through a series of reflection began to form macro themes. Thematic reflection was undertaken in several stages following the epoché and reduction. The researcher approached the qualitative data first as a whole text to examine meaning and significance of the text as an entire entity. This allowed the researcher to ease into the data and become intimately familiar with the text. It also allowed for general thoughts and reflections to surface.

A selective reading process was then undertaken whereby each interview was read individually and the phrases and experiences elicited given deep thought. The selective reading allowed for micro themes to emerge and be reflected upon. Some of the phrases used by the participants were particularly evocative and were highlighted for inclusion as rhetorical standouts when writing (van Manen, 2014).

Finally, a detailed reading approach was conducted whereby every sentence and sentence cluster were examined regarding what they expressed about the phenomenon of using NIV. In some cases, reflection on single words was undertaken to better understand the way the participants had chosen to describe their experiences. In their unconscious choice of words, the participants may have revealed experiential feelings of which they were not aware. This consideration and reflection further developed the macro themes. In this research, the macro themes were identified because they were distinct in the participants' experiences. The researcher continued to engage and re-engage with the data during thematic reflection until all the participants' experiences had been reflected upon and there was an authentic account of their experiences. The researcher then moved on to writing the results of the thematic analysis of the qualitative data.

4.7.4 The Vocative

Van Manen (2014, p. 31) believed “The reflective process of phenomenological inquiry largely happens in the practice of writing”. The reflective writing process constituted the largest portion of qualitative analysis in this project. Through reflection on the written words, writing the qualitative results chapter produced the final results of the research as the constant engagement of the researcher in the data allowed for new insights. As the researcher became more and more engaged with the data, the themes which had originally emerged became threaded through the transcripts.

The results of the qualitative data analysis presented in Chapter 6 were written as an experiential text aiming to create a sense of resonance in the reader, as was suggested by van Manen (2014, p. 240). The purpose of writing in this manner, according to van Manen (2014, p. 240) is to “allow the reader to recognise the plausibility of an experience, even if he or she has never personally experienced this particular moment or kind of event”. To allow for this type of relationship to develop between the reader and the participants, the qualitative text is deeply embedded with the words of the participants. This was to create a ‘nearness’ of the reader to the words of the nurses; to allow the participants to speak directly to their audience and thus allow the audience to see the data in a manner that is revealing of the participants’ experiential sense (van Manen, 2014, p. 249). Drawing the audience towards the raw experiences described in the data has been described as an evocative method of writing and aims to move meaning to a more proximal standpoint (van Manen, 2014, p. 249).

The participants told stories to describe their experiences. Using the evocative method, several of these stories were represented in the data as phenomenological examples of singular events. Contrary to other scientific methods, examples are not used in phenomenology to promote or explain an idea, the example itself is the idea as a singular entity. Including examples in phenomenological writing is another method of inquiry and allows the researcher to discover what is exemplary about an event. Reporting a participant’s experiences does not have the ability to capture this singularity because language cannot capture a singularity by naming or describing it (van Manen, 2014, p. 258). As van Manen (2014, pp. 258–259) pointed out “Language universalizes. But ... the ‘phenomenological example’ as story provides access to the phenomenon in its singularity”.

The act of writing requires reflection whether the author is aware of this or not. This refers to reflection on the memory being written about and the words being used to write. Writing a phenomenological text requires reflection on both what is written about and what is written. In this sense, it involves both the act of putting pen to paper (or fingers to keyboard) and all of the processes that contribute to those words. For an author to be able to write, they must also read what is written and reflect on those words. In this research project, writing the qualitative data results had multiple purposes as it allowed the researcher to engage with and reflect on the data. In writing, the researcher entered a state of wonder where new insights could occur. The process of reflective writing also enhanced the ability of the data to lead the researcher through analysis as it added a spatial element that is not present in writing without reflection (van Manen, 2014, p. 362). It is probably for this reason that the process of writing the qualitative results chapter was so lengthy and underwent multiple transformations before being concluded. The researcher spent lengthy periods of time at writing boot camps and away on writing retreats to ensure the writing and reflection process received the time it required. The process of reflection and writing led the researcher on a journey that sometimes felt circular, before reaching the final themes. These are presented in Chapter 6.

4.8 Step 6: Integration of the Quantitative and Qualitative Results

Integral to mixed methods research is the combination of quantitative and qualitative data to give an overarching perspective of the research phenomenon. In the sequential explanatory design, the quantitative and qualitative phases meet at both Step 3 and Step 6 of the research project (see Figure 4.1). In Step 6, the quantitative and qualitative data that have been analysed separately are viewed as a whole. This integration of the results and discussion is imperative in the sequential explanatory design and occurs in the final stage of the project (Creswell, Plano Clark, Gutmann, & Hanson, 2003). Qualitative data that were used to explore certain aspects of the quantitative data were examined in relation to their origins in the quantitative data. The integration of the quantitative and qualitative results can be found in Chapter 7.

4.9 Ethics

This project required review from two separate ethics committees. It was first reviewed by a lead Human Research Ethics Committee (HREC). The application to the lead HREC was

sent on 25 November 2015 and approved on 19 February 2016 (Reference: HREC/15/GWAHS/122). Authorisation was then sought from the Charles Sturt University HREC and granted on 24 February 2016 (Reference: 2016/021).

After initial approval by the lead HREC and the Charles Sturt University HREC, gaining site-specific approval from each of the nine sites in which data collection would take place was mandatory for full approval. This required the researcher to meet with (in person or via phone) each of the hospital managers to explain the research project, answer questions and provide information. This was significantly time consuming as the travel, working within other people's schedules and conducting meetings were a long process. The researcher commenced the site-specific approval process immediately after receiving the lead HREC approval on 19 February 2016 and site-specific approval from all nine sites was granted on 5 May 2016. The entire ethics approval process accounted for approximately six months of the three years required to conduct the study.

Major ethical considerations for this project included an assessment of risk, requirements for consent, data collection and storage. These were all measured against the standards defined by the 'National Statement on Ethical Conduct in Human Research (2007) – Updated May 2015' (NHMRC, 2007). Risk, as defined by the NHMRC (2007, p. 12), is the potential for harm, discomfort or inconvenience and includes an assessment of the likelihood and severity of harm. The risk assessment undertaken for this project was conducted in two stages, first, by examining the risk associated with the quantitative research phase, and second, by examining the risk associated with the qualitative research phase.

The quantitative phase of this research project held low risk. As it involved only collection of secondary data from hospital records and did not require interaction with participants, the main ethical considerations were consent, confidentiality and data storage. To address the issue of consent the researcher deemed it appropriate to apply for a waiver of individual consent so that medical records could be viewed with hospital consent only. The NHMRC (2007, pp. 21–22) allows for a waiver of consent under certain circumstances including:

- a) Involvement in the research carries no more than low risk to participants,
- b) The benefits from the research justify any risks of harm associated with not seeking consent,
- c) It is impracticable to obtain consent (for example, due to the quantity, age or accessibility of records),

- d) There is no known or likely reason for thinking that participants would not have consented if they had been asked,
- e) There is sufficient protection of their privacy,
- f) There is an adequate plan to protect the confidentiality of data,
- g) In case the results have significance for the participants' welfare there is, where practicable, a plan for making information arising from the research available to them (for example, via a disease-specific website or regional news media),
- h) The possibility of commercial exploitation of derivatives of the data or tissue will not deprive the participants of any financial benefits to which they would be entitled, and
- i) The waiver is not prohibited by state, federal, or international law.

The ethics committee agreed the research proposal satisfied all the requirements for a waiver of consent but required the data to be stored under stringent conditions. The researcher had initially proposed collecting and storing all of the quantitative data in the online database SurveyMonkey, however, this was deemed too high risk. Instead, it was agreed that the re-identifiable data be stored locally on the researcher's computer and only de-identified data be stored in SurveyMonkey. The two data files were coded so the researcher could match data sets.

The qualitative phase of this research project required consideration of ethical issues such as privacy, informed consent and data storage. Participation in interviews was advertised broadly through group email to all eligible nurses. Participants were then able to register their interest or ask questions via confidential email. All correspondence occurred via email. The study protocol, participant information and consent sheets were sent to all participants to allow time for questions. On the day of the interviews, the participants were given time to ask questions and the researcher went through the information and consent form with them. All consent forms were signed prior to the interviews taking place. The interviews were conducted on hospital grounds in every instance. The participants were given the opportunity to choose a location, providing it was private. Otherwise, the researcher organised private rooms located out of public view. All interviews were recorded on an electronic recording device and saved onto a locked computer prior to departure from the hospital. The participants' names were not stated on the record therefore only de-identified data were collected from the interviews.

4.10 Chapter Summary

This chapter has discussed the methods used to conduct the data collection and analysis in this research project. A sequential explanatory design was used whereby quantitative data collection and analysis were conducted and followed by qualitative data collection and analysis. The quantitative phase of this project followed a retrospective cohort design where data were collected retrospectively from medical records and statistically analysed. The results of that analysis were then used to plan the qualitative phase of the research. Phenomenology was used to design the qualitative data collection and analysis methods. These methods included the use of semi-structured interviews which were transcribed and used for thematic analysis.

The results of the data collection and analysis described in this chapter are found in the following chapters. First, the results of the quantitative analysis will be presented in Chapter 5. The results of the thematic analysis of the qualitative data will be presented in Chapter 6. Finally, in Chapter 7, both sets of results will be examined together and the qualitative data that sought to provide an explanation of aspects of the quantitative data will be explored.

Chapter 5: Quantitative Results

5.1 Introduction

This chapter discusses the results of the quantitative phase of this research project. As outlined in the previous chapter on methodology, the sequential explanatory design used in this project requires that the quantitative phase is completed before the qualitative phase of the research commences. This is to allow for the quantitative data and results to be used to formulate questions to be further explored qualitatively in the subsequent phase of the project. This chapter addresses the quantitative data that were collected and analysed. Three research questions will be addressed in this chapter:

1. How many patients with an acute exacerbation of asthma were treated with NIV and what type of NIV was used?
2. Which hospitals and specialty areas used NIV to treat acute asthma?
3. Does NIV provide better clinical outcomes for patients with an acute exacerbation of asthma compared to standard medical treatment?

5.2 Population

The medical records of all patients who presented to an emergency department in the MLHD between 2010 and 2015 with an acute exacerbation of asthma were examined during the quantitative phase of this research project. The researcher had the ability to access all relevant medical records in the LHD for the specified time period. The medical records included in this study are considered to be representative of a specific population. The profile of the population studied is defined as patients who:

- had an emergency presentation to a hospital capable of providing NIV as a treatment in the MLHD
- presented with an acute exacerbation of asthma
- met local criteria for treatment with NIV
- were aged ≥ 18 years at the time of presentation and
- presented to the hospital between 2010 and 2015.

The researcher was sent a list of the complete population by the Area Data Coordinator as per the stipulations of the ethics approval. The list included patient medical record number, date of admission, site of admission, and age at time of admission. The data were checked

for records that did not fit the population profile such as those who presented to hospitals not included in this study or were < 18 years old at the time of presentation. These were removed. The researcher then applied to each hospital for access to hard copy medical records and personally visited each site to collect data from these records. The full set of inclusion and exclusion criteria were then applied to every individually recorded admission, as shown in Table 5.1.

Table 5.1 Inclusion and exclusion criteria for eligibility of NIV

Inclusion criteria	Exclusion criteria
Category 1 pH 7.1–7.35 Respiratory rate \geq 30 breaths/min pCO ₂ 45–90 mmHg	Upper airway obstruction Severe upper airway bleeding Respiratory arrest Facial trauma, facial burns, or abnormalities that prevent mask seal
Category 2 Respiratory rate \geq 30 breaths/min Admitting physician notes describe asthma as ‘severe’, ‘extremis’ or patient able to speak in ‘single words only’	Glasgow Coma score < 10 PaO ₂ < 60 mmHg on a fraction of inspired oxygen of 100% pCO ₂ > 90 mmHg or pH > 7.1 Unrelieved pneumothorax (those without a chest drain) Recent upper airway surgery (above the level of the diaphragm) Vomiting on admission

Figure 5.1 shows the progression of the researcher’s examination of the medical records from the preliminary 3383 presentations to the initial application of exclusion criteria, division into individual hospitals, and identification of those who were eligible for NIV followed by those who received it. Eligibility for NIV was determined by the inclusion and exclusion criteria as shown in Table 5.1. For this study, the patients who were eligible for NIV will be referred to as having severe asthma. Patients were classified as receiving NIV if they had at any time during their stay in the ED met the inclusion criteria (without the presence of the exclusion criteria), or for those in rural facilities who bypassed the ED, met the criteria in the first four hours of their admission.

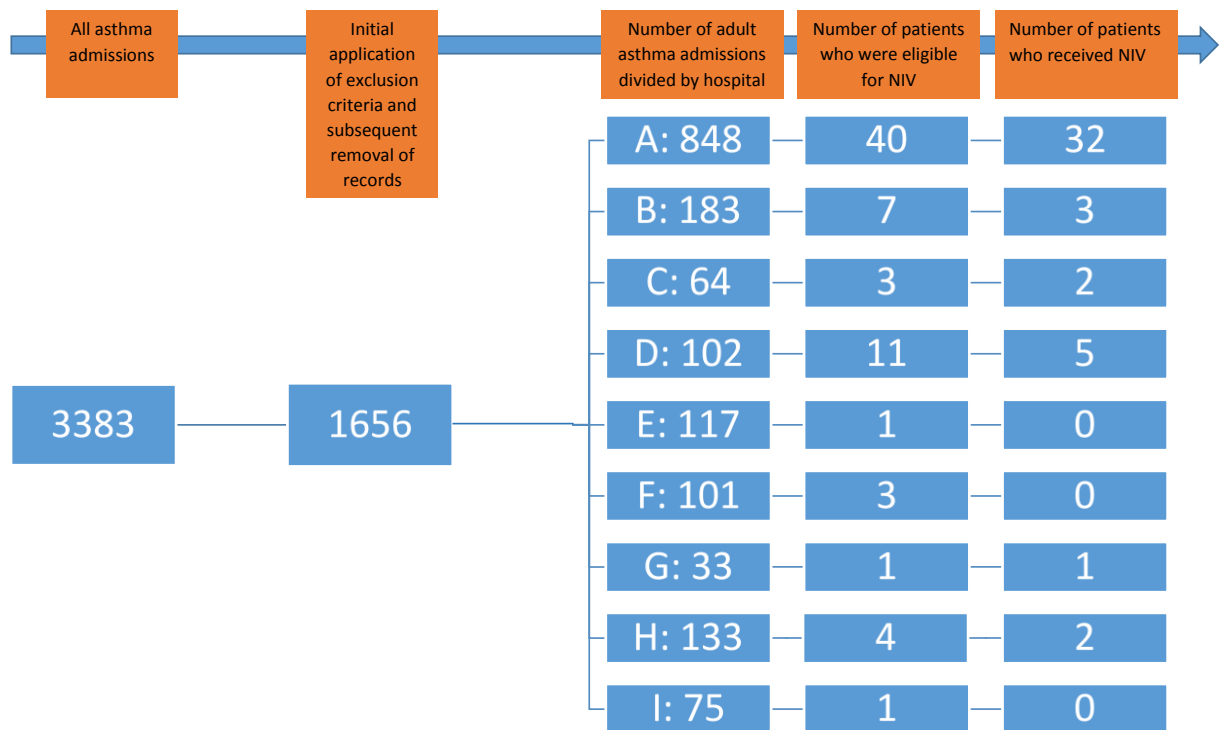


Figure 5.1 Progression of the researcher’s examination of the medical records

There were 71 patients eligible for NIV treatment between 2010 and 2015 in the hospitals included in this study. Of the patients who were eligible for a trial of NIV, 48 (67%) were female. The average age of patients eligible for NIV was 50.7 years (standard error = 19.1 years). The number of severe adult asthma presentations between 2010 and 2015 were examined as a percentage of all adult asthma presentations by year to examine changes over the study period across the health district. This is shown in Figure 5.2.

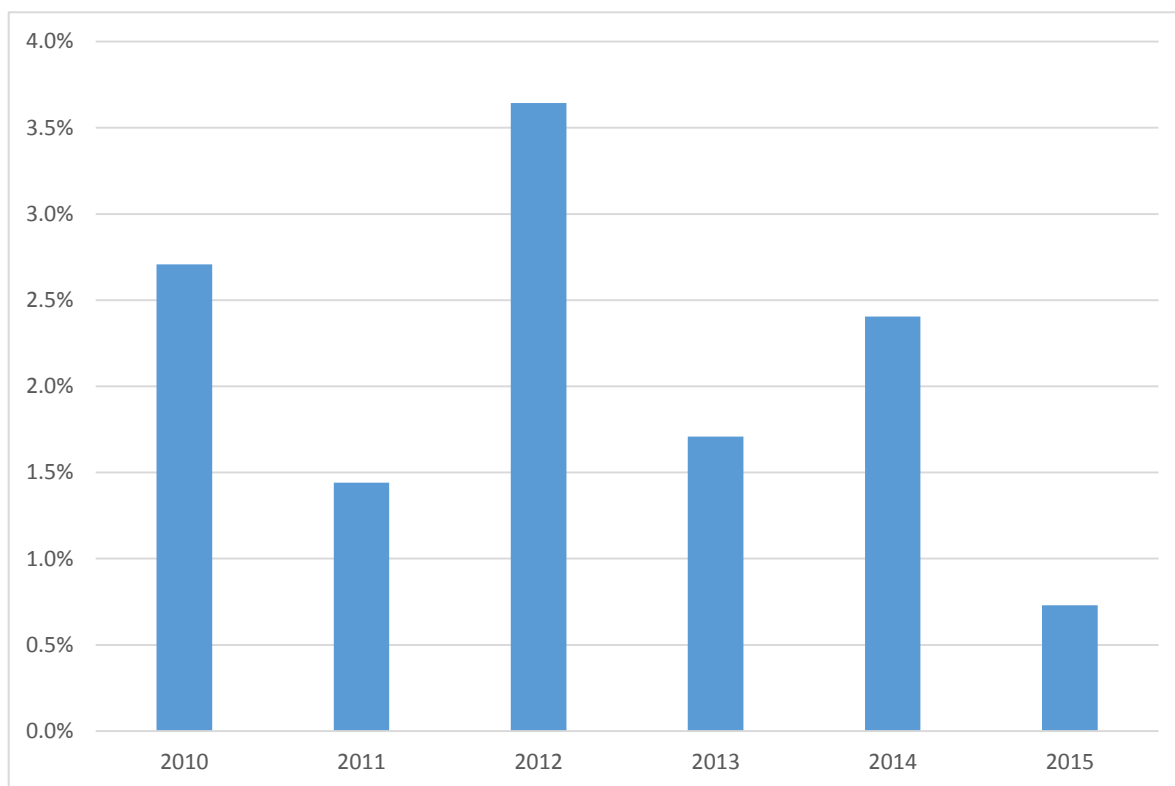


Figure 5.2 Percentage of adult asthma presentations classified as severe

Figure 5.2 shows that 2012 had the highest percentage of adult asthma admissions classified as severe, followed by 2010 and 2014. A Fisher's Exact test was used to determine if the severity of asthma was significantly affected by year. Asthma severity was significantly affected by year ($p = .016$).

Documented comorbidities were also recorded for all the patients who presented to an ED with a severe exacerbation of asthma. This is presented in Figure 5.3. Over half (52%) of these patients had a recorded allergy, 19 (27%) were currently smoking, and 20 (28%) had a current diagnosis of hypertension. Fifteen (21%) patients also had a concurrent diagnosis of gastro-oesophageal reflux disease (GORD). Four (5.6%) of the patients included in this study had a documented, concurrent diagnosis of COPD.

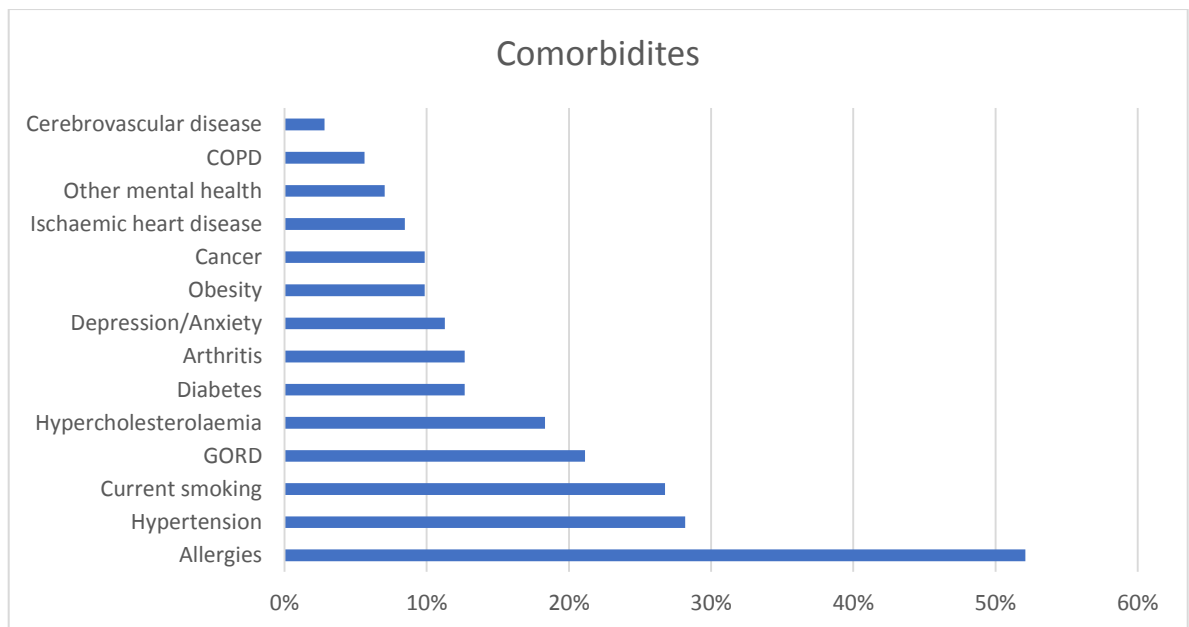


Figure 5.3 Documented comorbidities for the studied population

Data were also collected to determine if patients had received spirometry in the ED at any time from their presentation to transfer of care. Only eight patients received spirometry during this time (11%).

5.3 Research Question 1 – How many patients with an acute exacerbation of asthma were treated with NIV and what type of NIV was used?

This research question was answered by examining the entire population of patients presenting to the facilities included in this study between 2010 and 2015. The population was then divided into those who did receive NIV and those who did not. Of the 71 patients who were eligible for NIV, 45 (63%) received the treatment. The patients who received NIV treatment are compared to those who did not receive NIV in Table 5.2.

Table 5.2 Patients who received NIV compared to those who did not (\pm standard error)

Independent variables	NIV	No NIV
Sex (female)	0.76 \pm 0.06	0.54 \pm 0.10
Age (years)	49 \pm 2.94	53 \pm 3.61
Admission heart rate (bpm)	122 \pm 3.57	112 \pm 3.05
Admission mean arterial pressure (mmHg)	102 \pm 2.99	114 \pm 4.20
Acute Physiology and Chronic Health Evaluation II score	10.38 \pm 1.85	4.67 \pm 0.67
Intubated (yes)	0.30 \pm 0.06	0.08 \pm 0.06
ICU admission required (yes)	0.67 \pm 0.07	0.38 \pm 0.10
ICU length of stay (hours)	71.02 \pm 11.55	18.04 \pm 6.48
Hospital length of stay (days)	7.00 \pm 0.64	3.55 \pm 0.67
Inter-hospital transfer (yes)	0.18 \pm 0.06	0.31 \pm 0.09
Survival to discharge (yes)	1.0 \pm 0.0	1.0 \pm 0.0

The comparison of the patients who received NIV to those who did not shows that females were more likely to receive NIV as a treatment than males (76% vs 24% respectively). A Chi-squared test of independence was performed to determine if sex was significantly related to the patients who received NIV. There was no significant effect of sex on NIV delivery ($p = .105$).

The types of NIV treatment administered were also examined to determine the most common treatment method being used. The most common types of NIV treatment administered were BiPAP (58%), followed by no NIV treatment (37%), a combination of BiPAP and CPAP (4.2%), and CPAP only (1.4%). This is shown in Figure 5.4.

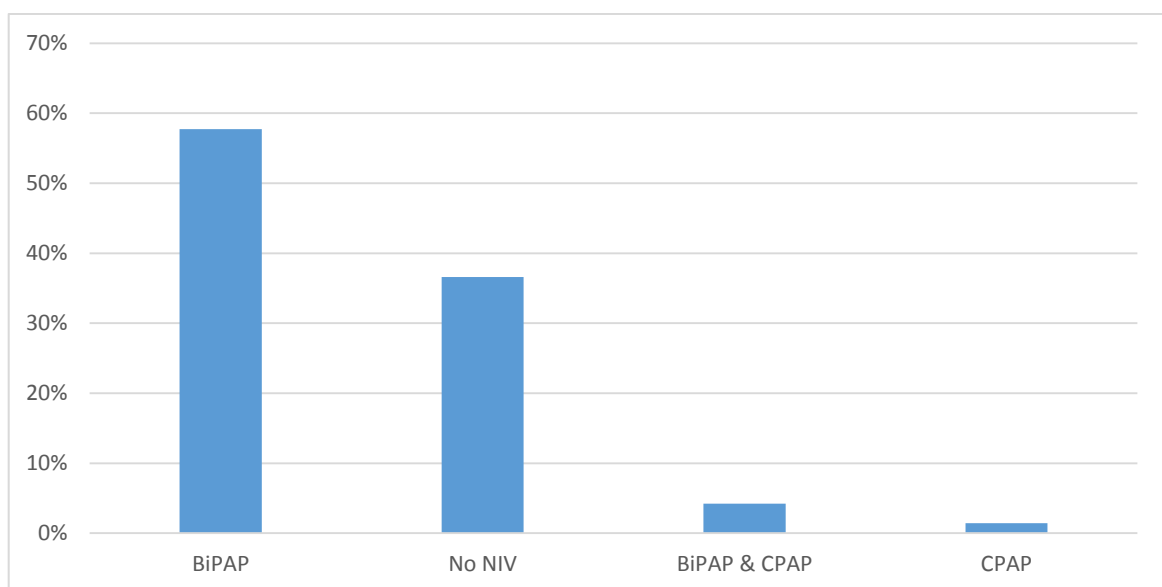


Figure 5.4 Types of NIV used during admission

5.4 Research Question 2 – Which hospitals and specialty areas used NIV to treat acute asthma?

To examine which hospitals and specialty areas used NIV as a treatment, the total population included in this study (i.e. all adult patients presenting with acute asthma to a specified hospital) was divided into individual hospital of presentation. This was to determine if there was any relationship between asthma presentations and individual hospitals and is shown in Table 5.3.

Table 5.3 Number of patients presenting with asthma grouped by hospital

Presenting Hospital	Total asthma presentations	Severe asthma presentations	Total of all asthma admissions classified as severe
Hospital A	860	40	4.65%
Hospital B	186	7	3.76%
Hospital C	64	3	4.69%
Hospital D	102	11	10.78%
Hospital E	118	1	0.85%
Hospital F	99	3	3.03%
Hospital G	31	1	3.26%
Hospital H	134	4	2.99%
Hospital I	85	1	1.18%

Table 5.3 demonstrates that some hospitals were more likely to receive presentations of asthma compared to others. The effect of individual hospital on the likelihood people would present with an exacerbation of asthma was tested using Fisher's Exact test. The individual hospitals were not related to patients presenting with an exacerbation of asthma ($p = .073$).

The effect of 'hospital and year' on the likelihood patients would present with severe asthma as a percentage of all asthma presentations was then examined using bar graphs. The graphs presented below (see Figure 5.5) show the percentage of asthma presentations classified as severe and categorised by hospital of presentation and year of presentation. The graphs show that not all years in all hospitals had presentations of severe asthma. Hospital A is the only hospital with severe asthma presentations every year across the study period. Only three of the nine hospitals had presentations of severe asthma in 2010, 2011 and 2015. Four of the hospitals had severe asthma presentations in 2014. Six hospitals had presentations recorded in 2013 and seven hospitals had presentations of severe asthma in 2012.

The highest percentages of presentations of asthma classified as severe occurred in Hospital D in 2011 (18%), followed by Hospital D in 2010 (15%), Hospital C in 2012 (14%), and Hospital G in 2014 (14%). Hospital D had > 10% of all asthma admissions classified as severe for four years of the study period. Three hospitals had > 10% of all asthma presentations classified as severe in 2012. An overview of the total study period showed that Hospital D had the highest percentage of asthma presentations classified as severe and Hospital E had the lowest. It appears that 2012 had the highest percentage of asthma presentations classified as severe across all hospitals and 2015 had the lowest. These data are represented graphically in Figure 5.5.

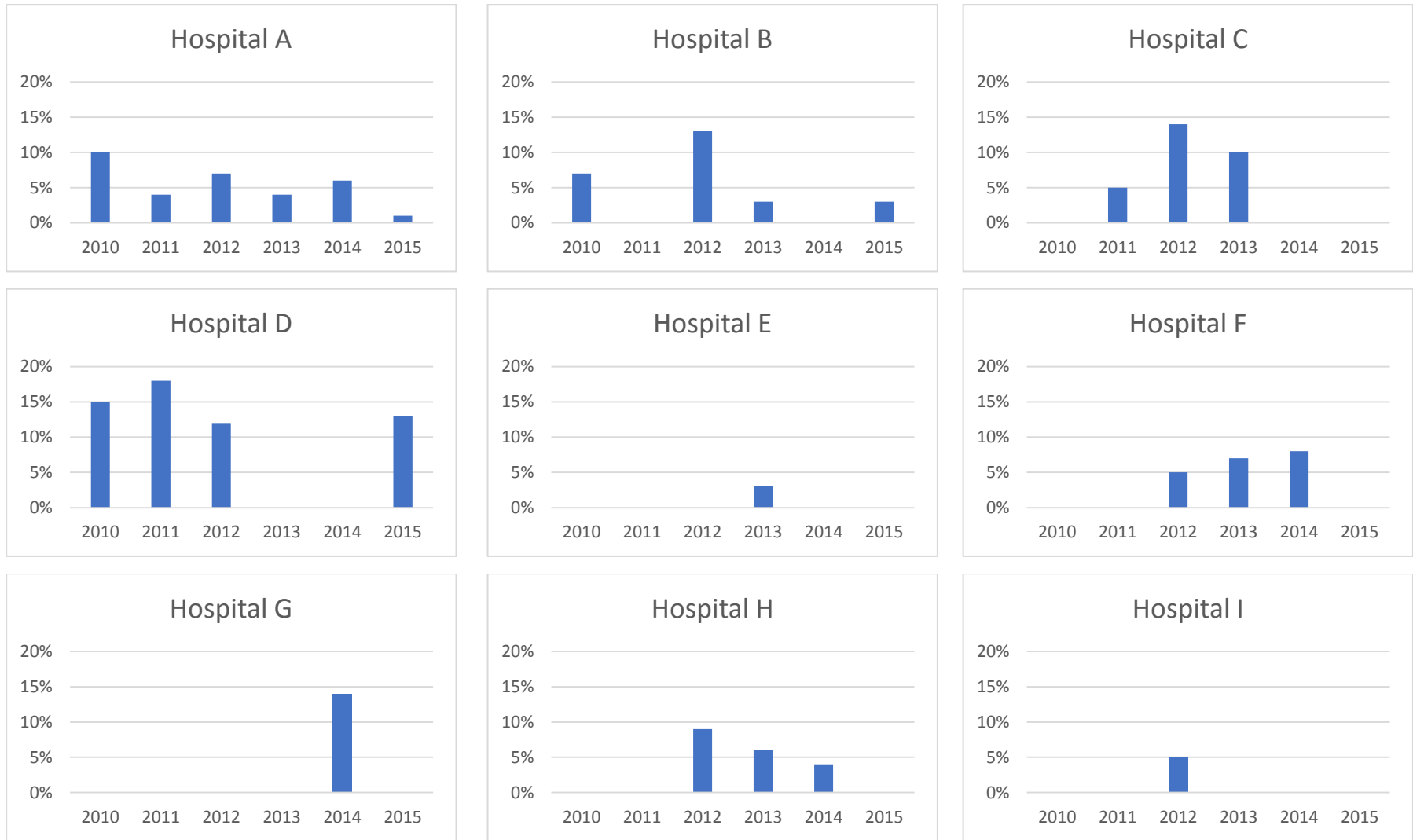


Figure 5.5 Percentage of asthma presentations classified as severe, categorised by hospital and year

The effect of hospital and year on severe asthma admissions was tested using Fisher’s Exact test. There was no significant relationship between hospital and year on severe asthma admissions ($p = .336$).

Once the data had been examined to identify the number of patients presenting to each hospital with severe asthma, they were divided into two groups: one group who received NIV and another group who did not receive NIV. Table 5.4 shows the total number of people presenting with severe asthma along with the number of those who received NIV, separated into the individual hospitals of presentation.

Table 5.4 Number of severe asthma presentations treated with NIV for each hospital

Presenting Hospital	Severe asthma presentations	Asthma presentations who received NIV	Percentage of severe asthma presentations who received NIV
Hospital A	40	32	80%
Hospital B	7	3	43%
Hospital C	3	2	67%
Hospital D	11	5	45%
Hospital E	1	0	0%
Hospital F	3	0	0%
Hospital G	1	1	100%
Hospital H	4	2	50%
Hospital I	1	0	0%

The table shows that in some hospitals, patients appeared to be more likely to receive NIV as a treatment. A Fisher’s Exact test was conducted to determine if the use of NIV was significantly related to hospital of presentation. Receiving NIV was not significantly related to the hospital of presentation ($p = .857$).

The hospitals were then grouped by size to determine if there was a difference in the likelihood of receiving NIV related to hospital size. Hospital size was defined as small (< 50 beds), medium (50–200 beds) and large (> 200 beds).

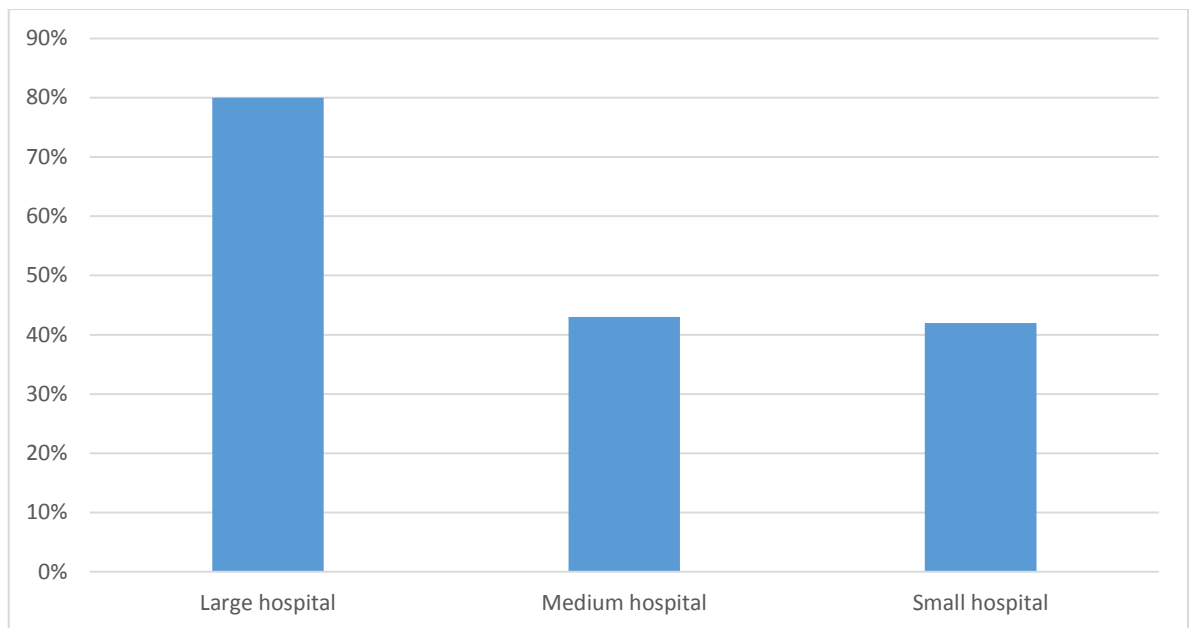


Figure 5.6 Percentage of patients who received NIV according to size of hospital of presentation

As shown in Figure 5.6, patients were more likely to receive NIV if they presented to a large hospital and least likely if they presented to a small hospital. A Fisher's Exact test was used to determine if hospital size was significantly related to the likelihood a patient would receive NIV. There was a significant relationship attributed to hospital size and the likelihood a patient would receive NIV ($p = .003$).

The use of NIV was then examined in relation to which specialty area the patient was in when they received NIV treatment. This was conducted to determine which areas were most likely to use NIV. These are presented as whole numbers as patients were commonly treated with NIV in more than one specialty area during one admission. Each instance of NIV use in a different specialty area was counted as an individual episode of treatment for these data only. The following graph (Figure 5.7) shows that the ED was the specialty area with most frequent NIV use and accounted for 38 episodes of NIV use. This was followed by the ICU (23 episodes of NIV use) and HDU (12 episodes of NIV use).

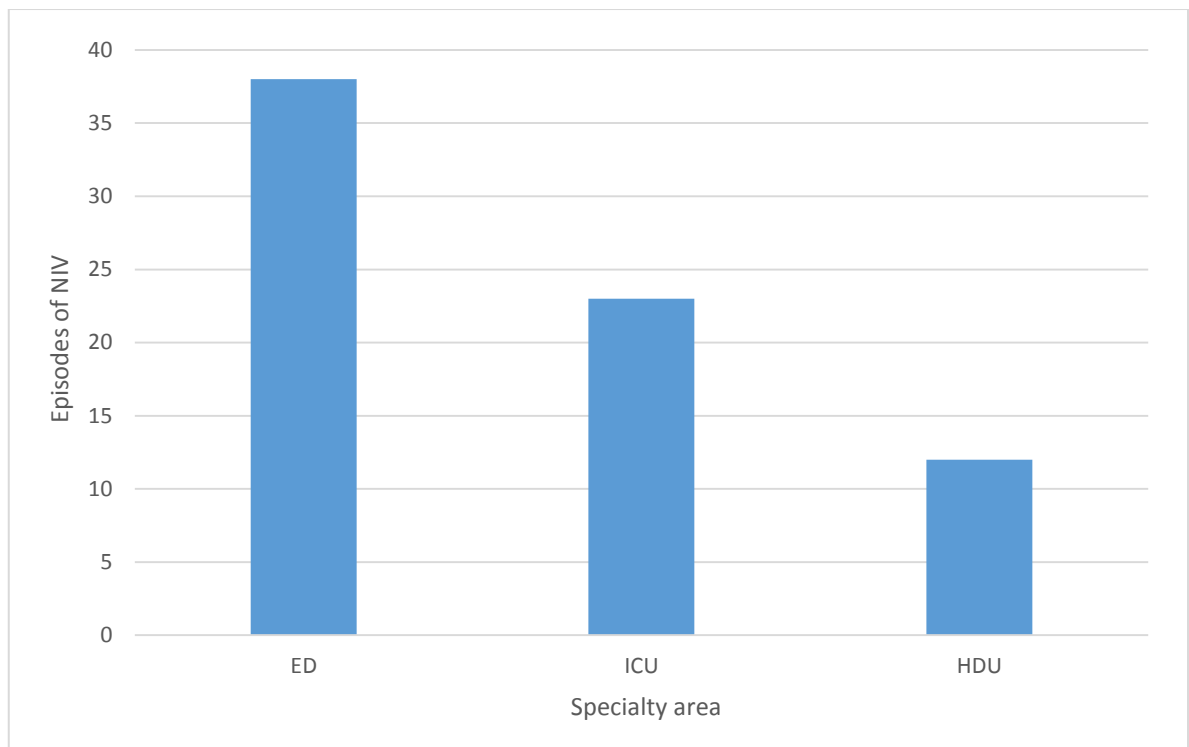


Figure 5.7 Episodes of NIV occurring in each specialty area

Of the patients who received NIV, 69% were admitted to ICU. For those who did not receive NIV, 38% required ICU admission. The relationship between admission to ICU and the use of NIV was tested using a Chi-squared test of independence. The use of NIV was significantly related to admission to ICU ($p = .025$).

5.5 Research Question 3 – Does NIV provide better clinical outcomes for patients with an acute exacerbation of asthma compared to standard medical treatment?

The final quantitative research question sought to determine if NIV could provide better clinical outcomes for patients with severe acute asthma compared to standard medical therapy alone. The clinical outcomes of specific interest were:

- short-term outcomes including pH, pCO₂ and respiratory rate measured at four hours from initiation of treatment
- medium-term outcomes including pH, pCO₂ and respiratory rate measured at 18 hours from initiation of treatment and
- long-term outcomes including ICU length of stay, hospital length of stay, and survival to hospital discharge.

The standard medical therapy each of the patients received during their admission with severe asthma was identified and divided into the ‘NIV’ and ‘no NIV’ groups. The standard medical therapy each of the patients received was prescribed by the treating medical officer at the time of admission, according to their discretion. Due to the retrospective nature of the data collection in this project, the researcher was unable to affect medications prescribed. Figures 5.8 and 5.9 show the medical therapy received by the patients in both groups. The graphs show the percentage of patients in each group who were prescribed each treatment during their admission.

For the patients who received NIV, 100% received oxygen, inhaled salbutamol and corticosteroids. The next most common treatments were antibiotics (96%) and inhaled atrovent (93%), followed by intravenous magnesium (58%) and intravenous salbutamol (38%). This is shown in Figure 5.8.

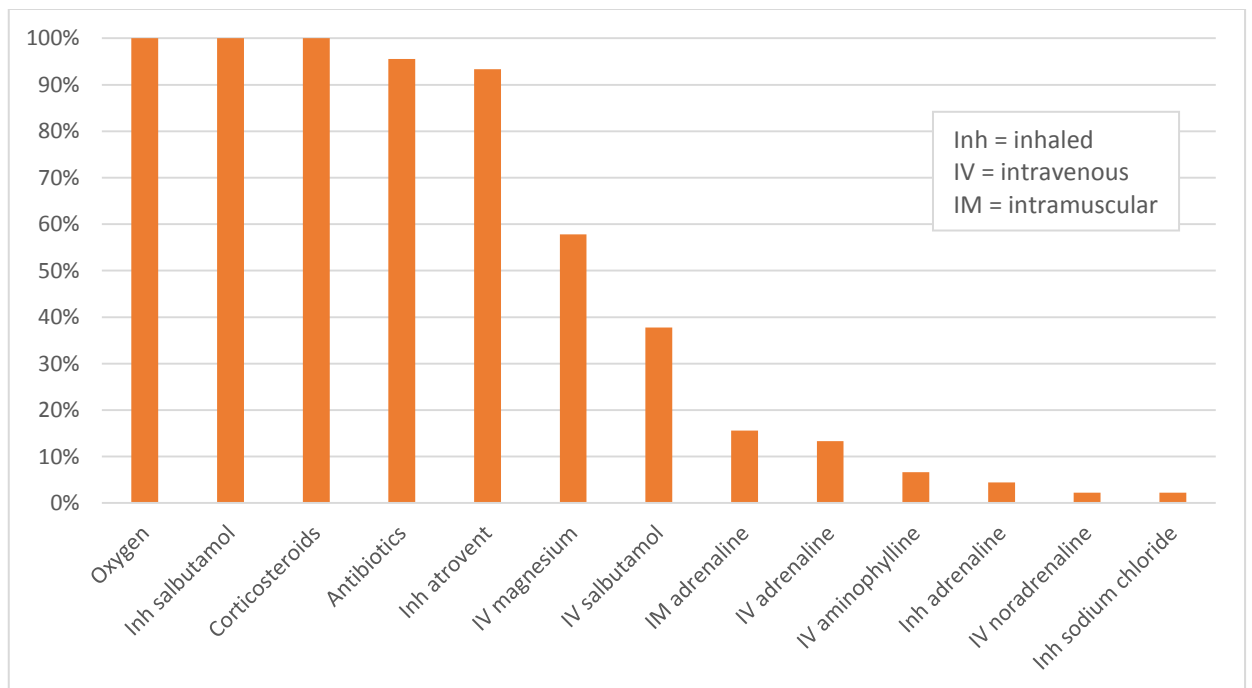


Figure 5.8. Standard medical therapy received by patients who were treated with NIV

The patients who did not receive NIV received similar medical treatment to those who did receive NIV. Oxygen and inhaled salbutamol were administered to 100% of these patients. In this group, corticosteroids were administered to 96% of patients. Antibiotics were administered to 62% of these patients and intravenous salbutamol was slightly more likely to be administered compared to intravenous magnesium (23% and 19% respectively). This

is illustrated in Figure 5.9. Patients who did not receive NIV also received fewer types of medical therapy. They did not receive any intravenous adrenaline, intravenous noradrenaline, inhaled sodium chloride or intravenous aminophylline – all of which were prescribed to patients in the NIV group.

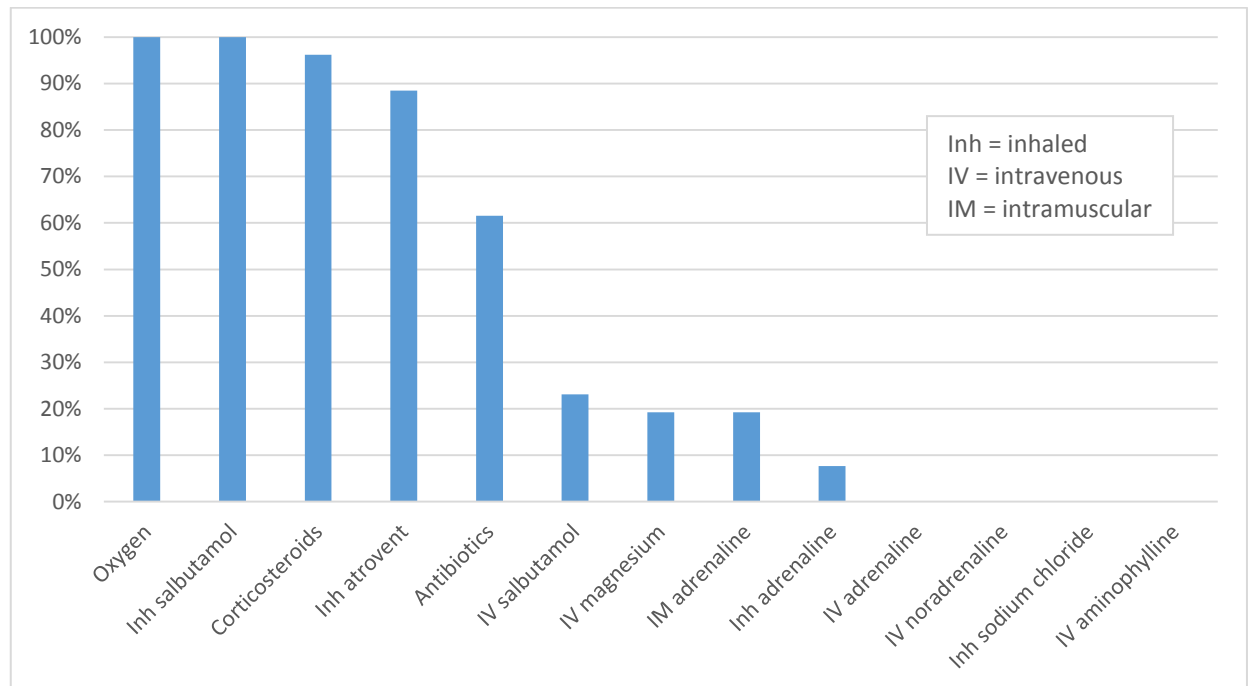


Figure 5.9. Standard medical therapy received by patients who were not treated with NIV

The type of standard medical therapy received by each group was analysed using Fisher’s Exact test to determine if there was a significant relationship in the type of medical therapy received by patients according to whether they received NIV. There was no significant difference between the NIV and no NIV group regarding the standard medical therapy they received ($p = .360$).

The two groups were then examined regarding their short- and medium-term outcomes: pH, pCO₂ and respiratory rate. The short-term outcomes are considered those measured at the 4-hour time point and the medium-term outcomes are considered those measured at the 18-hour time point.

5.5.1 Analysis of pH

The first short-term outcome tested was pH. It was tested using the values recorded for the 0-, 4- and 18-hour time points. The first analysis of pH considered the effect of NIV and

time on pH. A linear mixed model using ASReml in R was used (Butler, 2009). The analysis of variance for pH is shown in Table 5.5.

Table 5.5 Analysis of variance for pH

Model terms	Numerator degrees of freedom	F	<i>p</i>
NIV	1	0.12	.728
Time	2	12.68	< .001
NIV: Time	2	1.98	.144

The analysis of variance shows there is no significant effect of NIV or the interaction of NIV and time on pH ($p > .05$). Time did have a significant effect on pH ($p < .001$). The predicted values and rankings were examined for pH according to time. These are shown in Table 5.6.

Table 5.6 Predicted mean pH values for time (standard error of prediction)

Model term	Time		
	0 hours	4 hours	18 hours
pH	7.248 (0.032) ^a	7.289 (0.032) ^b	7.332 (0.034) ^c

Note: Rankings are interpreted by reading across rows. Different letters represent a 5% significant difference between the means

Table 5.6 shows that the predicted mean value of pH increased across the three time points. The predicted mean pH at each time point was significantly different to the other time points ($p < .05$). Figure 5.10 shows a graph of this relationship.

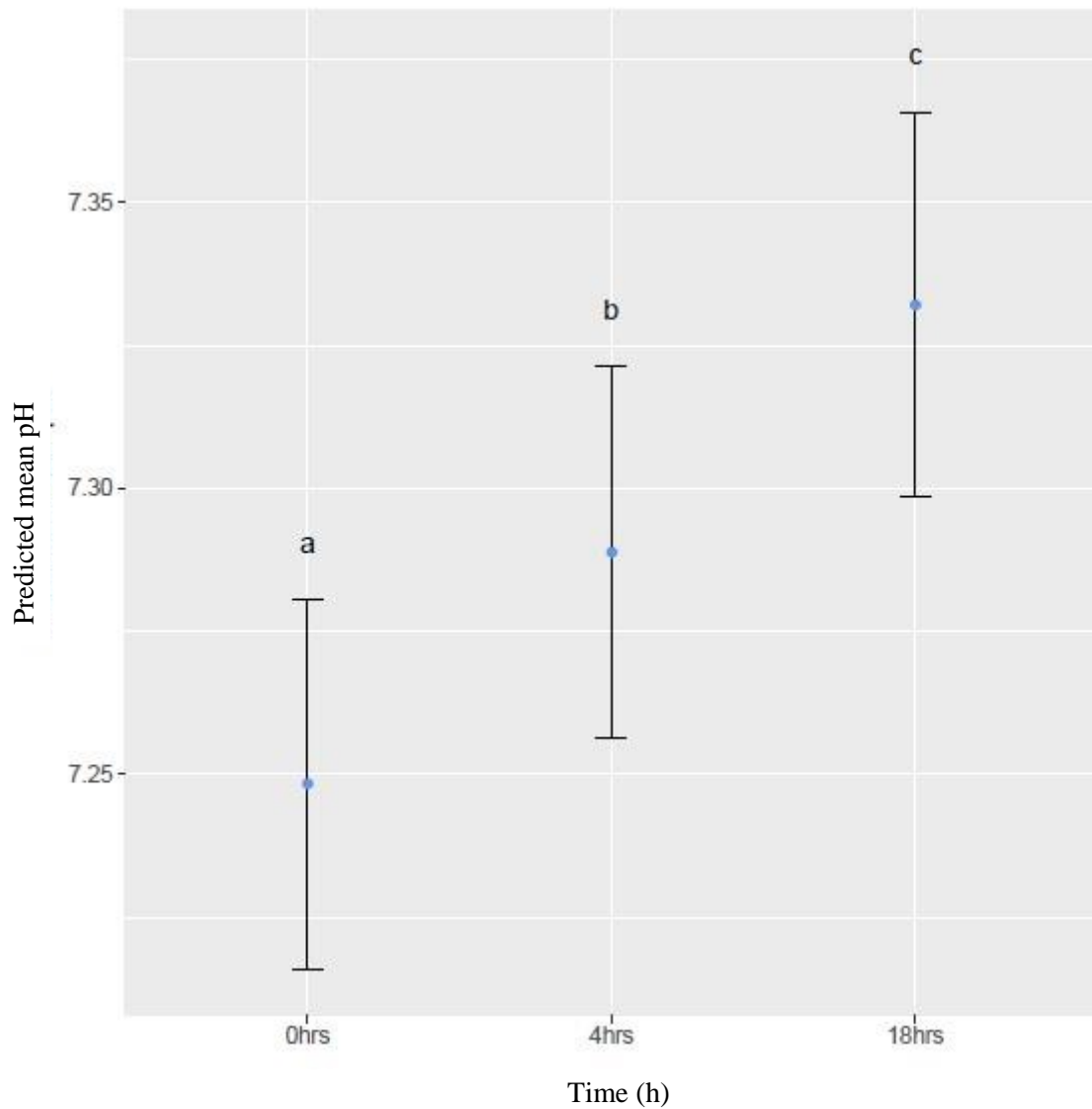


Figure 5.10 Predicted mean pH according to time with standard error

Although there was no statistically significant relationship between pH and the interaction of NIV and time, the predicted mean pH values for NIV: time interaction are shown in Table 5.7 for comparison.

Table 5.7 Predicted mean pH values for NIV: time (standard error of prediction)

NIV	Time		
	0 hours	4 hours	18 hours
Yes	7.245 (0.033)	7.285 (0.033)	7.340 (0.034)
No	7.278 (0.039)	7.308 (0.039)	7.266 (0.056)

This table is represented graphically in Figure 5.11.

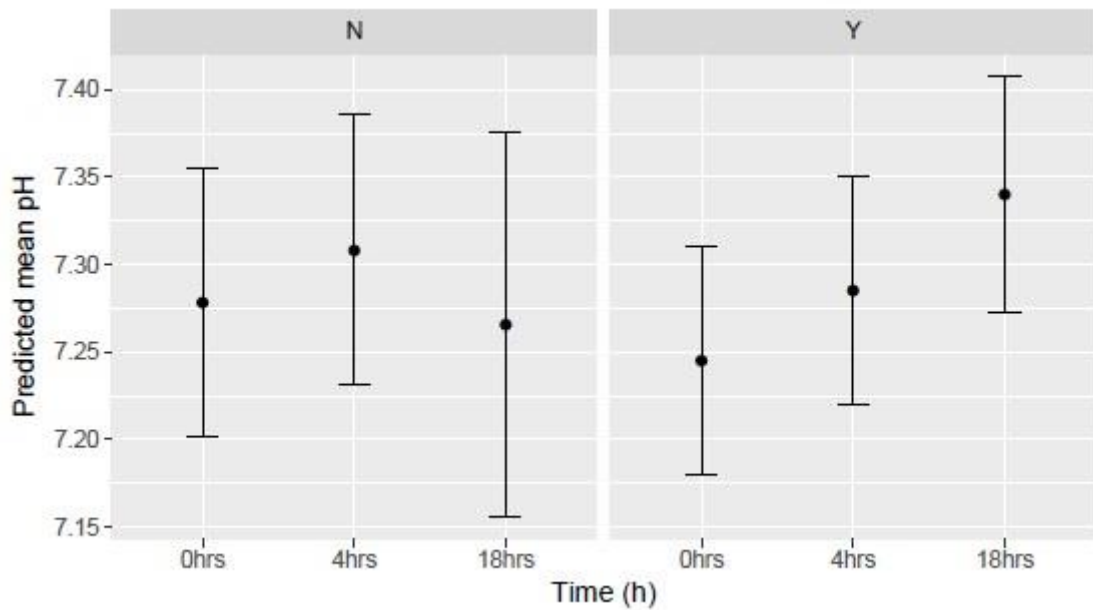


Figure 5.11 Predicted mean pH values shown with the interaction of NIV and time with standard error

The analysis of pH in relation to NIV and time accounted for covariates. The covariates tested in the model were:

- size of hospital
- age
- sex
- COPD
- smoking
- allergies
- spirometry
- hours from admission to NIV commencement
- total NIV hours
- need for intubation
- intubated on day number
- invasive ventilation hours
- ICU
- ICU length of stay (hours)
- hospital length of stay (days) and
- inter-hospital transfer.

There was a significant effect due to several covariates including COPD, ICU length of stay (hours), ICU, the interaction of spirometry and time, and the interaction of age and time ($p < .05$). This is shown in Table 5.8.

Table 5.8 Analysis of variance for pH

Model terms	Numerator degrees of freedom	F	<i>p</i>
Time	2	11.42	< .001
COPD	1	7.67	.010
ICU length of stay (hours)	1	11.37	.002
ICU	2	4.89	.010
Spirometry	1	1.29	.259
Age	1	0.01	.915
Spirometry: age	2	3.63	.032
Age: time	2	4.45	.015

Once significance was found, the predicted values and rankings (for the qualitative covariates) were examined. The predicted mean pH values for COPD and ICU are shown in Table 5.9.

Table 5.9 Predicted mean pH values for COPD and ICU (standard error of prediction)

Model terms	Yes	No
COPD	7.19 (0.05) ^b	7.26 (0.04) ^a
ICU	7.25 (0.04) ^b	7.21 (0.04) ^a

Note: Rankings are interpreted by reading across rows. Different letters represent a 5% significant difference between the means

The table shows patients with a current diagnosis of COPD had a lower predicted mean pH compared to those who did not have this diagnosis. Patients who were admitted to ICU had a significantly higher pH than those who were not ($p < .05$). Figures 5.12 and 5.13 show the graphed predicted mean pH values for COPD and ICU.

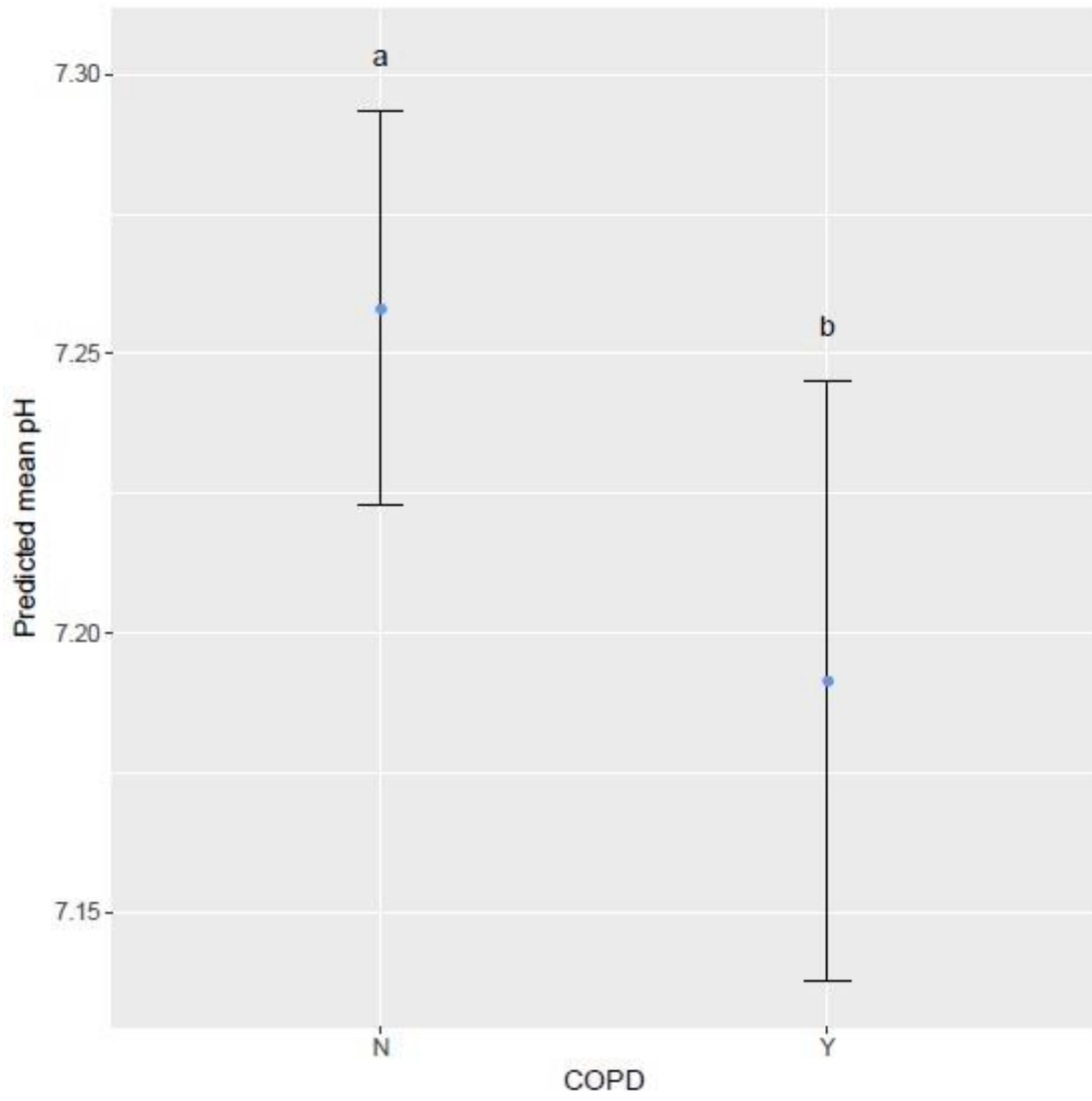


Figure 5.12 Predicted mean pH values for COPD with standard error

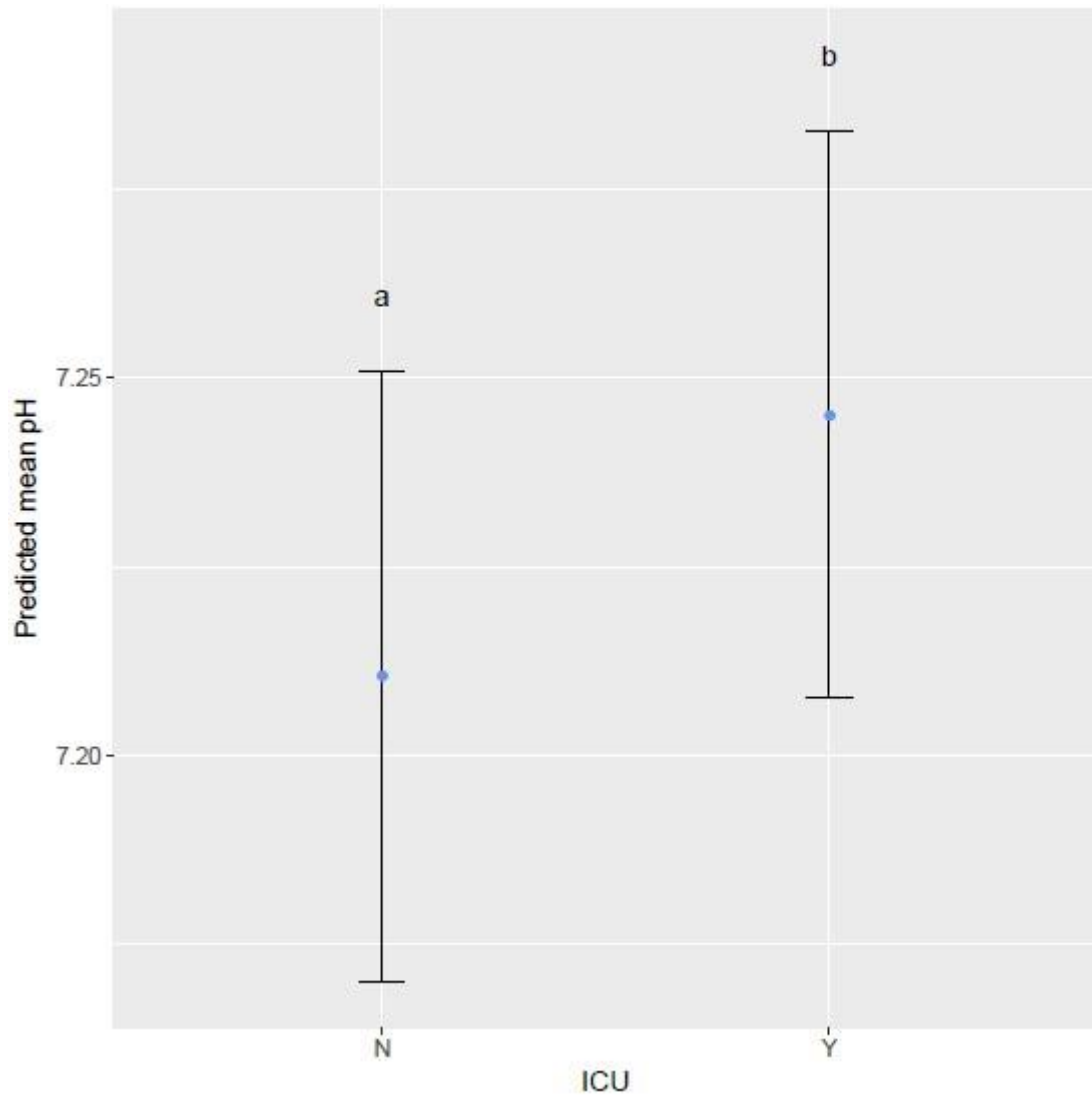


Figure 5.13 Predicted mean pH values for ICU with standard error

The predicted mean pH values for the interaction of spirometry and time are shown in Table 5.10.

Table 5.10 Predicted mean pH values for the interaction of spirometry and time (standard error of prediction)

Spirometry	Time		
	0 hours	4 hours	18 hours
Yes	7.26 (0.04) ^{ab}	7.25 (0.05) ^{ab}	7.22 (0.06) ^{ab}
No	7.19 (0.04) ^a	7.22 (0.04) ^a	7.28 (0.04) ^b

Note: Rankings are interpreted by reading across rows. Different letters represent a 5% significant difference between the means

Regarding the interaction between spirometry and time, the patients who were given spirometry were similar. The predicted mean pH of patients who did not attend spirometry was different at the 18-hour time point compared to the 0- and 4-hour time points, but were

similar to the mean pH of patients who attended spirometry. A graph of the predicted mean pH values for the interaction of spirometry and time is shown in Figure 5.14.

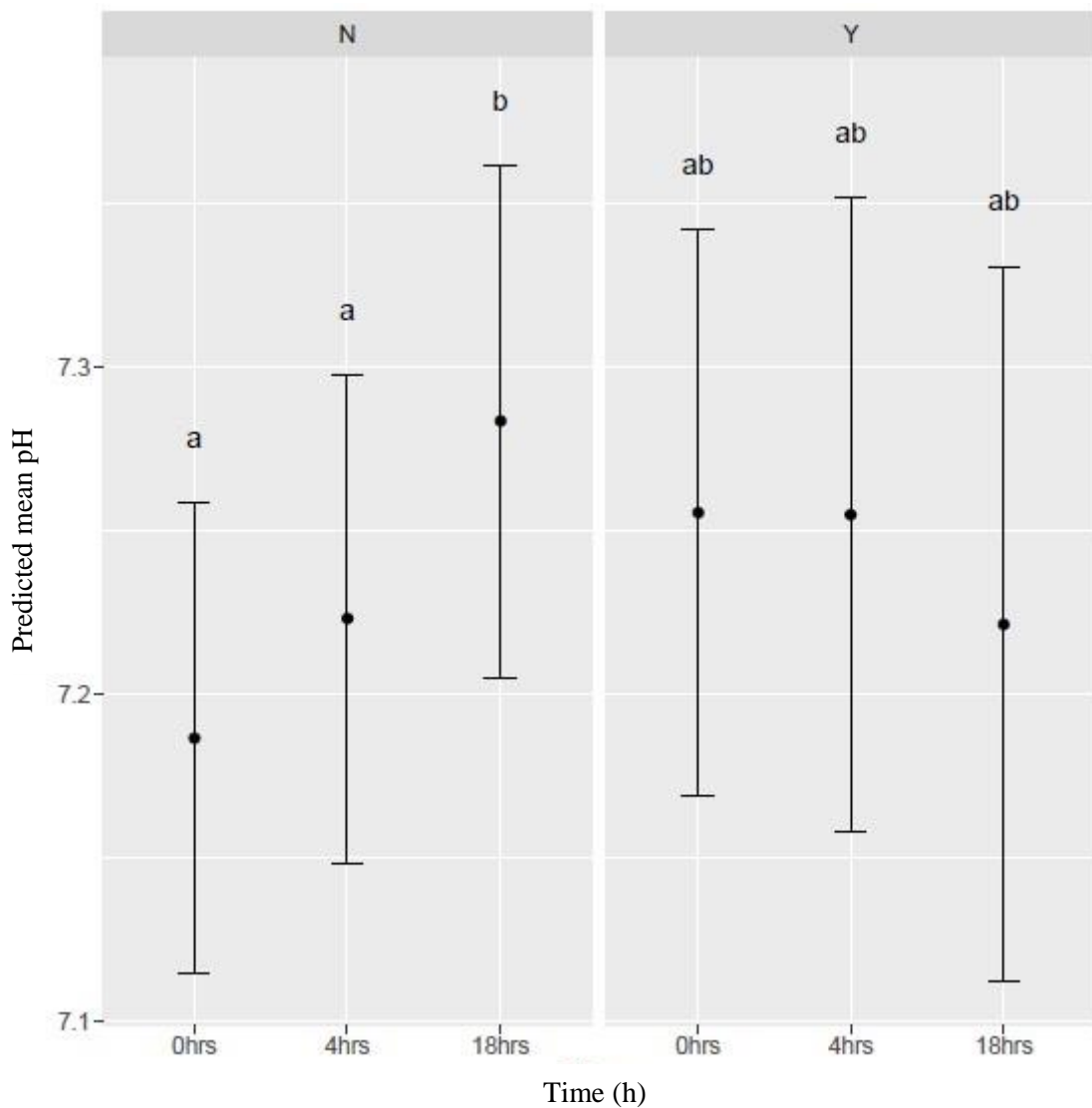


Figure 5.14 Predicted mean pH values for the interaction of spirometry and time with standard error

The predicted mean pH values according to age at each time point were then examined. These values are shown in Table 5.11.

Table 5.11 Predicted mean pH values according to age at each time point (standard error of prediction)

Age	Time		
	0 hours	4 hours	18 hours
20	7.21 (0.05)	7.17 (0.05)	7.20 (0.06)
25	7.21 (0.05)	7.17 (0.05)	7.20 (0.05)
30	7.20 (0.05)	7.18 (0.05)	7.21 (0.05)
35	7.20 (0.05)	7.18 (0.05)	7.21 (0.05)
40	7.19 (0.04)	7.19 (0.05)	7.21 (0.05)
45	7.18 (0.04)	7.20 (0.04)	7.22 (0.05)
50	7.18 (0.04)	7.20 (0.04)	7.22 (0.04)
55	7.17 (0.04)	7.21 (0.04)	7.22 (0.04)
60	7.17 (0.04)	7.21 (0.04)	7.22 (0.04)
65	7.16 (0.04)	7.22 (0.04)	7.23 (0.04)
70	7.16 (0.04)	7.22 (0.04)	7.23 (0.05)
75	7.15 (0.04)	7.23 (0.04)	7.23 (0.05)
80	7.15 (0.04)	7.23 (0.04)	7.23 (0.05)
85	7.14 (0.05)	7.24 (0.05)	7.24 (0.05)

The table shows that at the time treatment was commenced the higher a patient's age, the lower their pH. Conversely, at 18 hours the lower a patient's age, the lower their predicted pH. There was a consistent progression from lower to higher pH across the three time points for patients aged ≥ 40 years. Patients younger than 40 years had the same or similar pH at each time point. This is shown graphically in Figure 5.15.

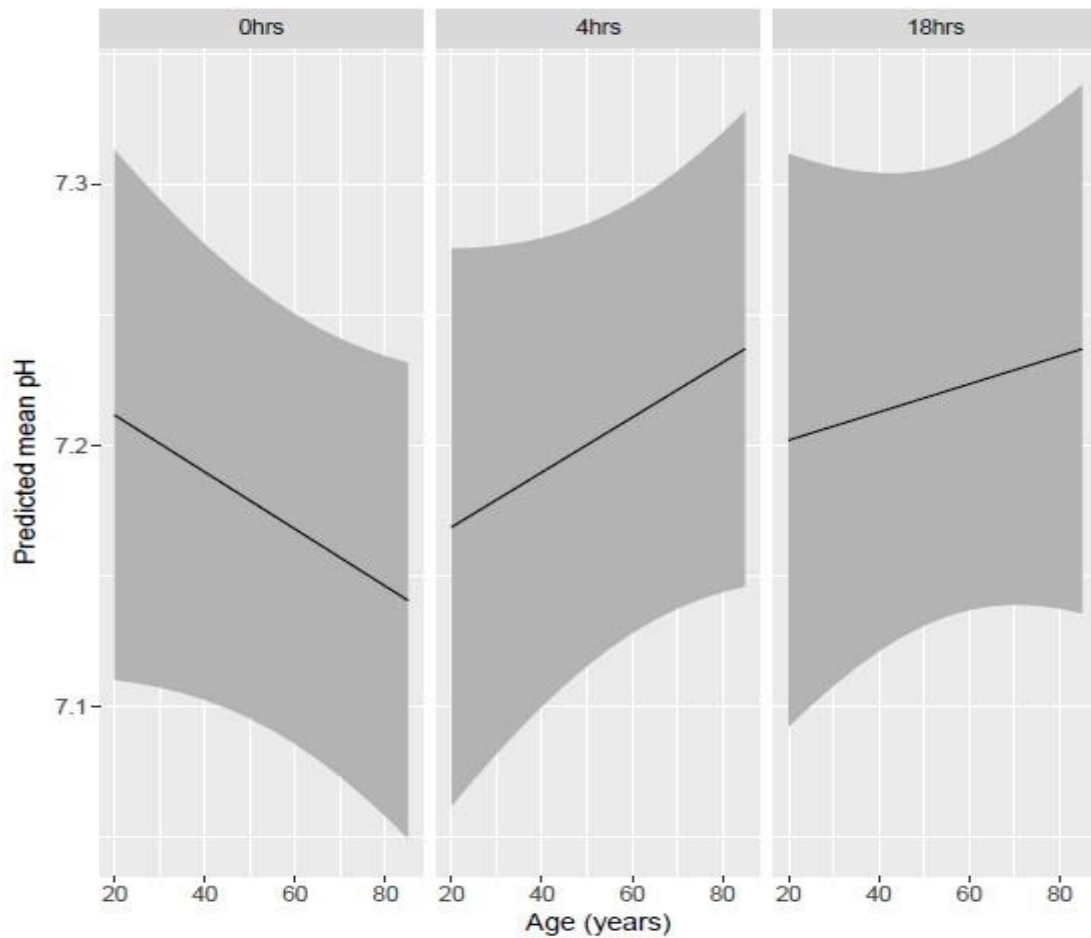


Figure 5.15 Predicted mean pH according to age with standard error

The predicted mean pH values were then examined according to ICU length of stay (hours). As ICU length of stay (hours) increased, the predicted value for pH decreased consistently by 0.02. The linear regression line relating pH and ICU length of stay (hours) is:

$$pH = 7.272 - 0.001 \times ICU \text{ length of stay (hours)}$$

This can be interpreted – for every hour spent in ICU the pH decreases by 0.001. This is represented graphically in Figure 5.16.

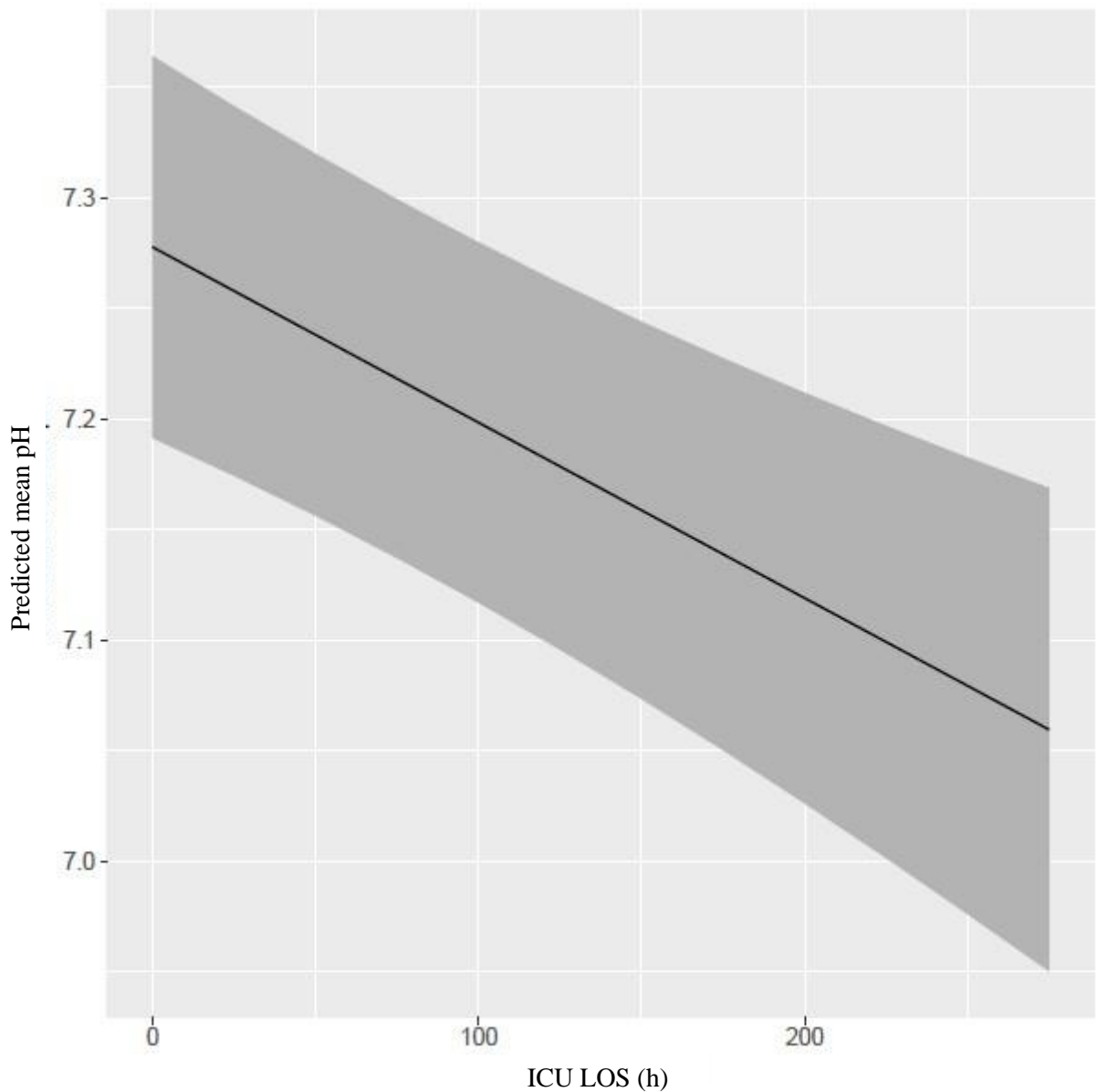


Figure 5.16 Predicted mean pH according to ICU length of stay (hours) with standard error

5.5.2 Analysis of pCO₂

The second linear mixed model focused on the effect of NIV, time and various covariates on pCO₂. A linear mixed model using ASReml in R was used (Butler, 2009). The analysis of variance for pCO₂ is shown in Table 5.12.

Table 5.12 Analysis of variance for pCO₂

Model terms	Numerator degrees of freedom	F	<i>p</i>
NIV	1	0.91	.342
Time	2	8.75	< .001
NIV: time	2	2.25	.112

The analysis of variance shows there is no significant effect of NIV or the interaction of NIV and time on pCO₂ ($p > .05$). Time did have a significant effect on pCO₂ ($p < .001$). The predicted values and rankings were examined for pCO₂ according to time. These are shown in Table 5.13.

Table 5.13 Predicted mean pCO₂ values for time (standard error of prediction)

Model term	Time		
	0 hours	4 hours	18 hours
PCO ₂	63.405 (5.231) ^b	54.953 (5.252) ^a	53.775 (5.472) ^a

Note: Rankings are interpreted by reading across rows. Different letters represent a 5% significant difference between the means

Table 5.13 shows that the predicted mean value of pCO₂ decreased across the three time points. The predicted mean pCO₂ at 0 hours was significantly different to the other time points ($p < .05$). Figure 5.17 shows a graph of this effect.

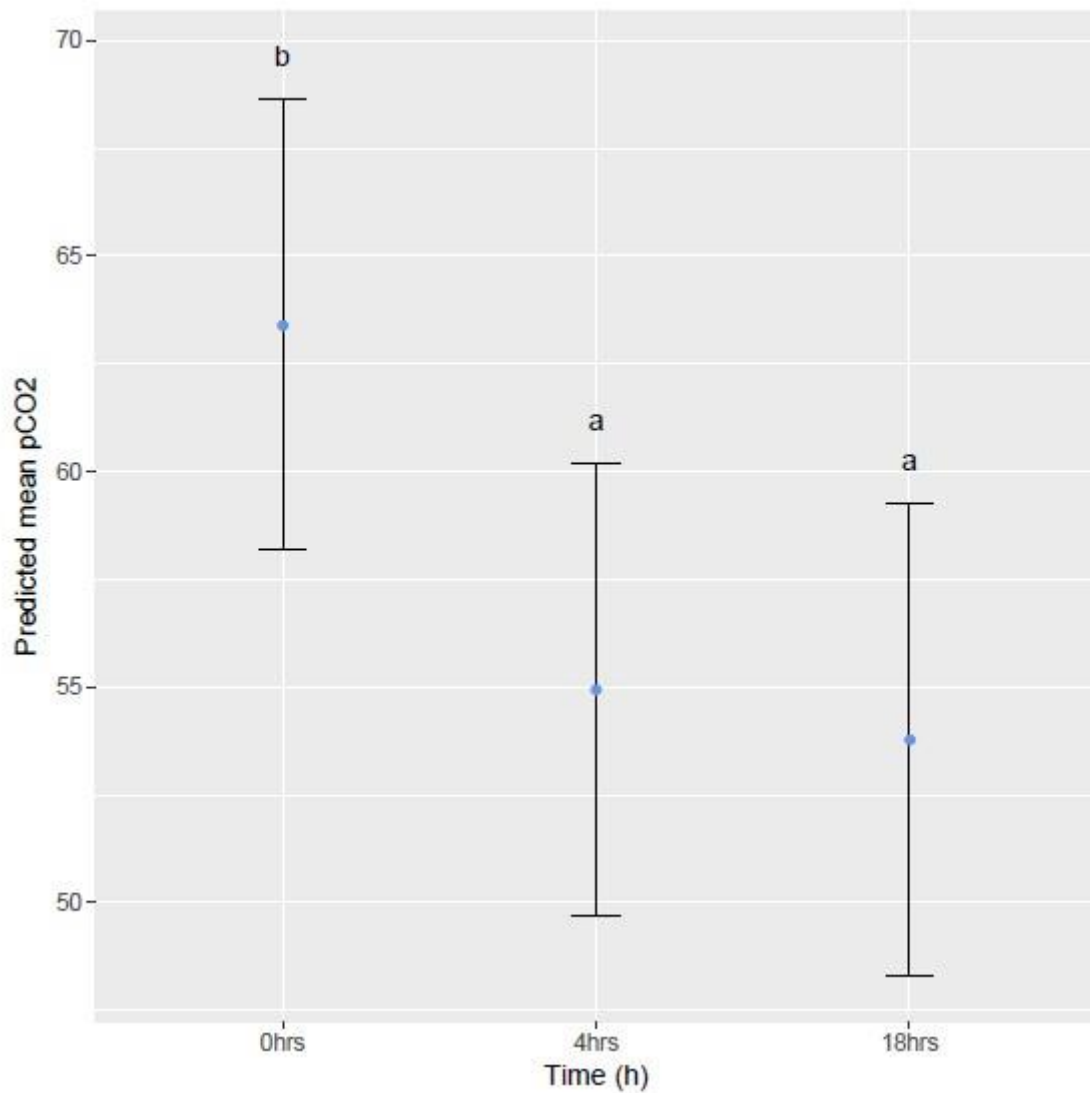


Figure 5.17 Predicted mean pCO₂ values across time points with standard error

There was no statistically significant relationship between pCO₂ and the interaction of NIV and time; the predicted mean pCO₂ values for NIV: time interaction are shown in Table 5.14 for comparison.

Table 5.14 Predicted mean pCO₂ values for NIV: time (standard error of prediction)

NIV	Time		
	0 hours	4 hours	18 hours
Yes	64.255 (4.974)	54.278 (5.001)	52.373 (5.225)
No	52.897 (6.334)	51.661 (6.428)	60.800 (9.506)

This table is represented graphically in Figure 5.18.

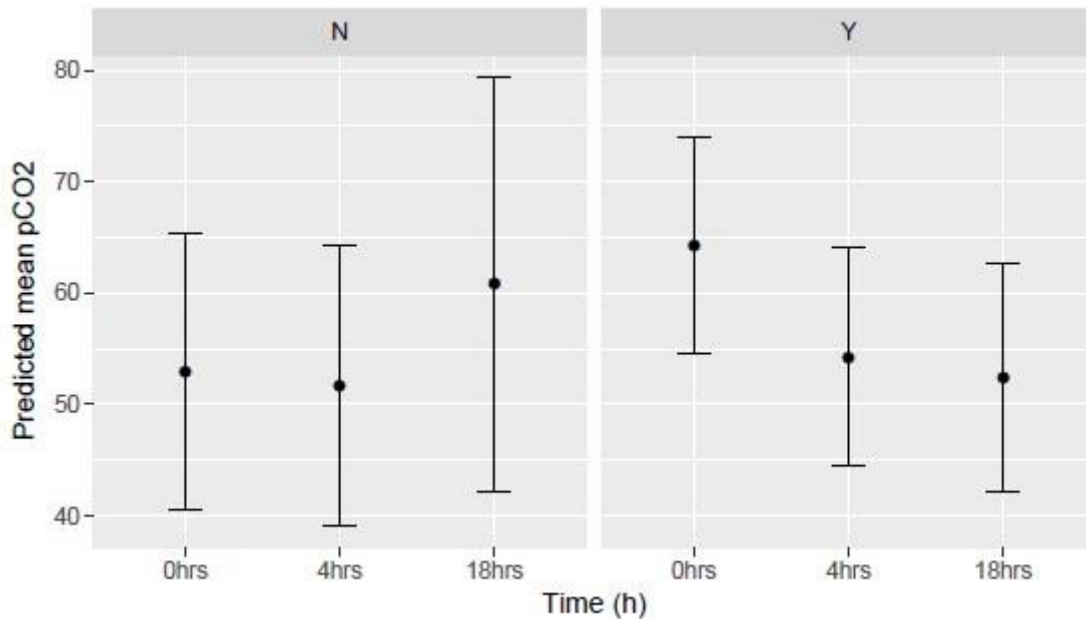


Figure 5.18 Predicted mean pCO₂ values for NIV: time with standard error

The analysis of pCO₂ in relation to NIV and time accounted for covariates. The covariates tested in the model were the same as those used in the analysis of pH. There was a significant effect due to several covariates including COPD, ICU length of stay (hours), ICU, the interaction of spirometry and time, and the interaction of age and time ($p < .05$). This is shown in Table 5.15.

Table 5.15 Analysis of variance for pCO₂

Model terms	Numerator degrees of freedom	F	p
Time	2	7.31	.001
ICU length of stay (hours)	1	15.10	< .001
Age	1	2.01	.165
Age: Time	2	3.54	.034

Table 5.15 shows a significant effect of time on pCO₂ ($p = .001$). There was also a significant effect due to two other covariates. These were ICU length of stay (hours) and the interaction of age: time ($p < .05$). Once significance was found the predicted values and rankings (for the qualitative covariates) were examined. The predicted mean pCO₂ values for ICU length of stay (hours) are shown in Table 5.16.

Table 5.16 Predicted mean pCO₂ values for ICU length of stay (hours) (standard error of prediction)

ICU length of stay (hours)	Predicted value
0	53.522 (6.481)
25	56.450 (6.253)
50	59.378 (6.111)
75	62.307 (6.061)
100	65.235 (6.104)
125	68.163 (6.239)
150	71.091 (6.461)
175	74.019 (6.760)
200	76.948 (7.127)
225	79.876 (7.552)
250	82.804 (8.025)
275	85.732 (8.540)

This is shown graphically in Figure 5.19.

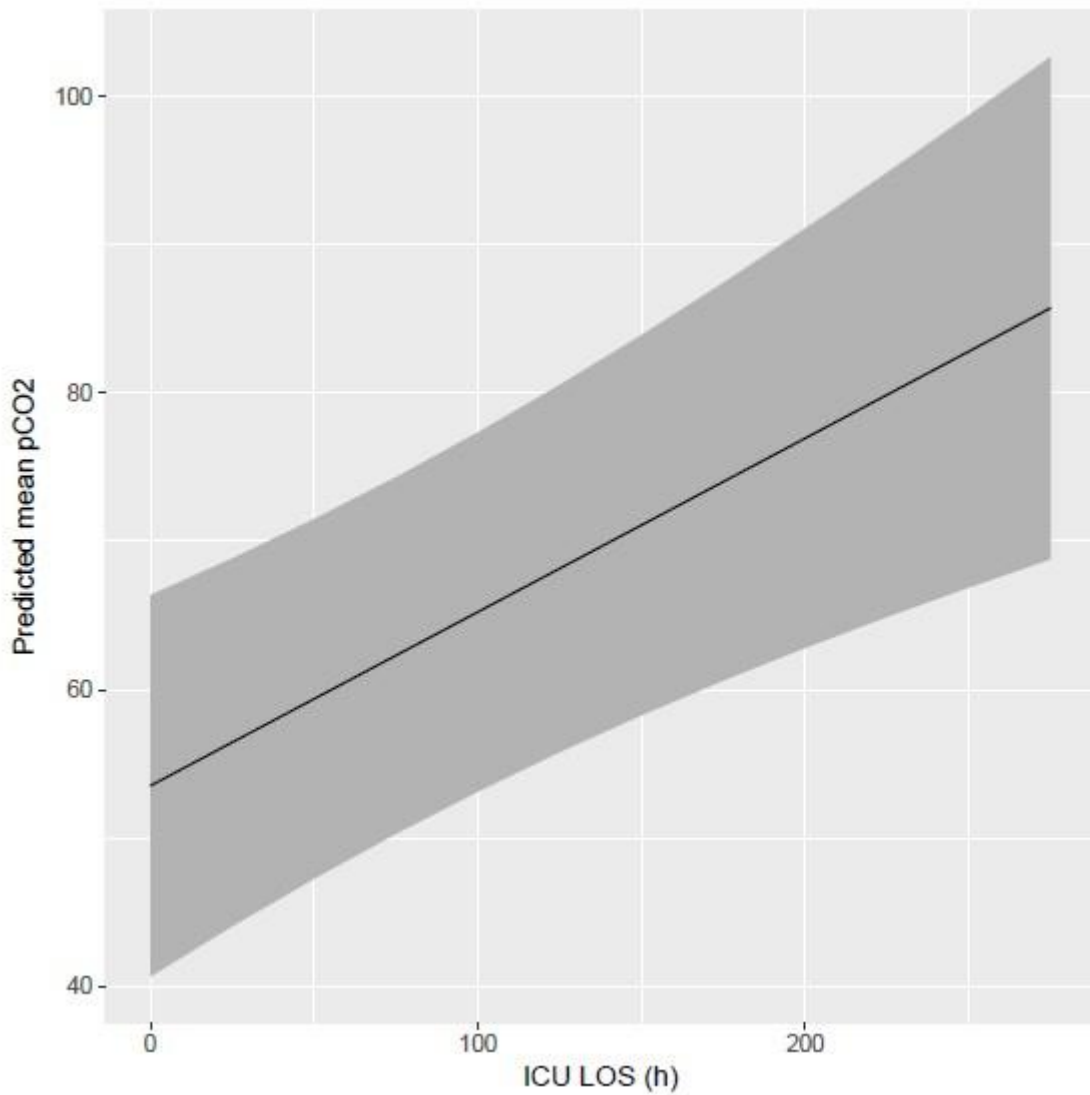


Figure 5.19 Predicted mean pCO₂ values for ICU length of stay (hours) with standard error

Figure 5.19 shows that as the ICU length of stay (hours) increases, the predicted mean pCO₂ also increases. The linear regression line relating pCO₂ and ICU length of stay (hours) is:

$$pCO_2 = 43.228 + 0.117 \times \text{ICU length of stay (hours)}$$

This can be interpreted – for every hour spent in ICU the pCO₂ increases by 0.117. The predicted mean pCO₂ values for age: time are shown in Table 5.17.

Table 5.17 Predicted mean pCO₂ values for age across time (standard error of prediction)

Age	Time		
	0 hours	4 hours	18 hours
20	61.8 (7.4)	62.5 (7.7)	58.6 (8.0)
25	63.5 (7.1)	62.6 (7.3)	59.0 (7.6)
30	65.2 (6.8)	62.7 (6.9)	59.3 (7.2)
35	67.0 (6.6)	62.8 (6.7)	59.6 (6.8)
40	68.7 (6.4)	62.9 (6.5)	60.0 (6.6)
45	70.4 (6.3)	63.0 (6.3)	60.3 (6.4)
50	72.2 (6.3)	63.1 (6.3)	60.6 (6.4)
55	73.9 (6.3)	63.2 (6.3)	60.9 (6.5)
60	75.6 (6.5)	63.3 (6.4)	61.3 (6.6)
65	77.3 (6.7)	63.4 (6.6)	61.6 (6.9)
70	79.1 (7.0)	63.5 (6.8)	61.9 (7.2)
75	80.8 (7.3)	63.6 (7.2)	62.2 (7.6)
80	82.5 (7.7)	63.7 (7.5)	62.6 (8.1)
85	84.3 (8.1)	63.8 (8.0)	62.9 (8.6)

Table 5.17 shows that the predicted mean pCO₂ increased as age increased at zero hours. This trend was the same for the 4-hour and 18-hour time points. There was a difference in predicted mean pCO₂ between the youngest and oldest age groups of 22.5 at zero hours. This difference decreased to 1.3 by the 4-hour time point and was 4.3 at the 18-hour time point. For each age group, the predicted pCO₂ consistently decreased from the 0-hour time point to the 4-hour time point. The pCO₂ also consistently decreased between the 4-hour and 18-hour time points in each age group. The only exception to this trend was in the 20-year-old age group where the predicted mean pCO₂ was 61.8 at zero hours and then increased to 62.5 at the 4-hour time point before decreasing to 58.6 at the 18-hour time point. These values are represented graphically in Figure 5.20.

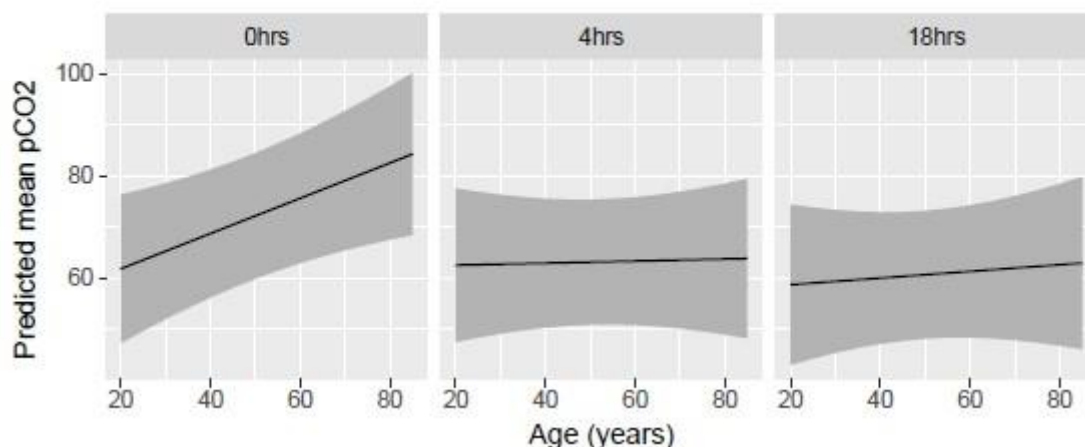


Figure 5.20 Predicted mean pCO₂ values for age: time with standard error

5.5.3 Analysis of Respiratory Rate

The next linear mixed model analysis focused on respiratory rate. The effect of NIV and time on respiratory rate was first examined. A linear mixed model using ASReml in R was used (Butler, 2009). The analysis of variance for respiratory rate is shown in Table 5.18.

Table 5.18 Analysis of variance for respiratory rate

Model terms	Numerator degrees of freedom	F	<i>p</i>
NIV	1	4.20	.045
Time	2	110.90	< .001
NIV: time	2	4.43	.013

Table 5.18 shows there was a significant effect due to NIV on respiratory rate ($p < .05$). There was also a significant effect of time on respiratory rate ($p < .001$). The interaction of NIV and time also had a significant effect on respiratory rate ($p = 0.013$). Predicted values were then examined. These are shown in Table 5.19.

Table 5.19 Predicted mean respiratory rate values for the interaction of NIV: time (standard error of prediction)

	Time		
	0 hours	4 hours	18 hours
NIV			
Yes	30.8 (0.9) ^c	22.4 (0.9) ^{ab}	20.3 (0.9) ^{ab}
No	35.3 (1.2) ^d	24.3 (1.2) ^b	19.4 (1.2) ^a

Note: Rankings are interpreted by reading across rows. Different letters represent a 5% significant difference between the means

Table 5.19 shows the predicted mean respiratory rates at zero hours were significantly different for the NIV and no NIV groups. The predicted respiratory rates were similar for

the NIV and no NIV groups at the 4-hour and 18-hour time points. The predicted respiratory rate for the patients who received NIV was significantly different at four and 18 hours compared to the predicted respiratory rate for these patients at zero hours. The predicted respiratory rates for the patients who did not receive NIV were different across all three time points ($p < .05$). The predicted mean respiratory rates for the interaction of NIV: time are shown graphically in Figure 5.21.

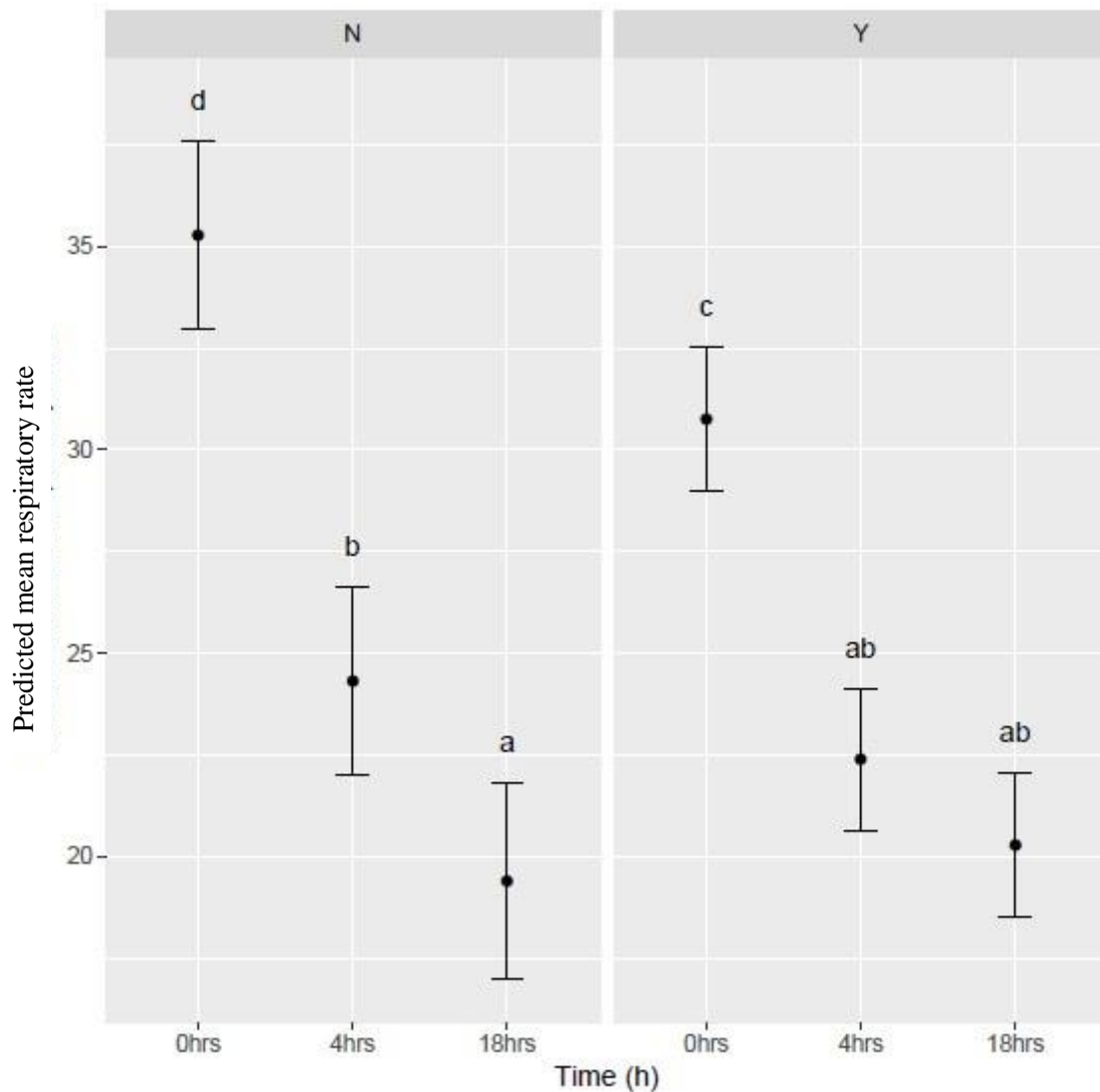


Figure 5.21 Predicted mean respiratory rates for the interaction of NIV: time with standard error

The analysis of respiratory rate in relation to NIV and time accounted for covariates. The covariates tested in the model were the same as those tested in the analysis of pH. Table 5.20 shows the analysis of variance results for the covariates in the analysis of respiratory rate.

Table 5.20 Analysis of variance for respiratory rate

Model terms	Numerator degrees of freedom	F	<i>p</i>
NIV	1	4.23	.044
Time	2	125.40	< .001
NIV: time	2	5.02	.008
Size of hospital	2	0.14	.871
Size of hospital: time	4	4.84	.001
Hours from admission to NIV commencement	1	1.42	.238
Hours from admission to NIV commencement: time	2	3.34	.038

The analysis of variance shows the combination of NIV and time had a significant effect on respiratory rate ($p = .008$). There was also a significant effect due to the interaction of size of hospital and time ($p < .05$). The predicted mean respiratory rate values for the interaction of size of hospital and time are shown in Table 5.21.

Table 5.21 Predicted mean respiratory rates for size of hospital: time (standard error of prediction)

Size of Hospital	Time		
	0 hours	4 hours	18 hours
Small	32.16 (1.29) ^c	25.78 (1.26) ^b	19.56 (1.31) ^a
Medium	37.48 (2.11) ^c	18.55 (2.11) ^{ab}	20.49 (2.11) ^{ab}
Large	32.12 (1.09) ^c	23.31 (1.09) ^{ab}	20.53 (1.10) ^{ab}

Note: Rankings are interpreted by reading across rows. Different letters represent a 5% significant difference between the means

Table 5.21 shows at zero hours the predicted mean respiratory rate across all three hospital sizes was the same. The predicted mean respiratory rate for the three hospital sizes was also the same at four and 18 hours. The small hospitals had statistically different values of predicted mean respiratory rate at zero, four and 18 hours ($p < .05$) which decreased at each time point. The large and medium hospitals had significantly different predicted mean respiratory rates at the 4-hour and 18-hour time points compared to those at zero hours ($p > .05$) but there was no difference between the predicted respiratory rates at the 4-hour and 18-hour time points for these hospitals. This information is shown graphically in Figure 5.22.

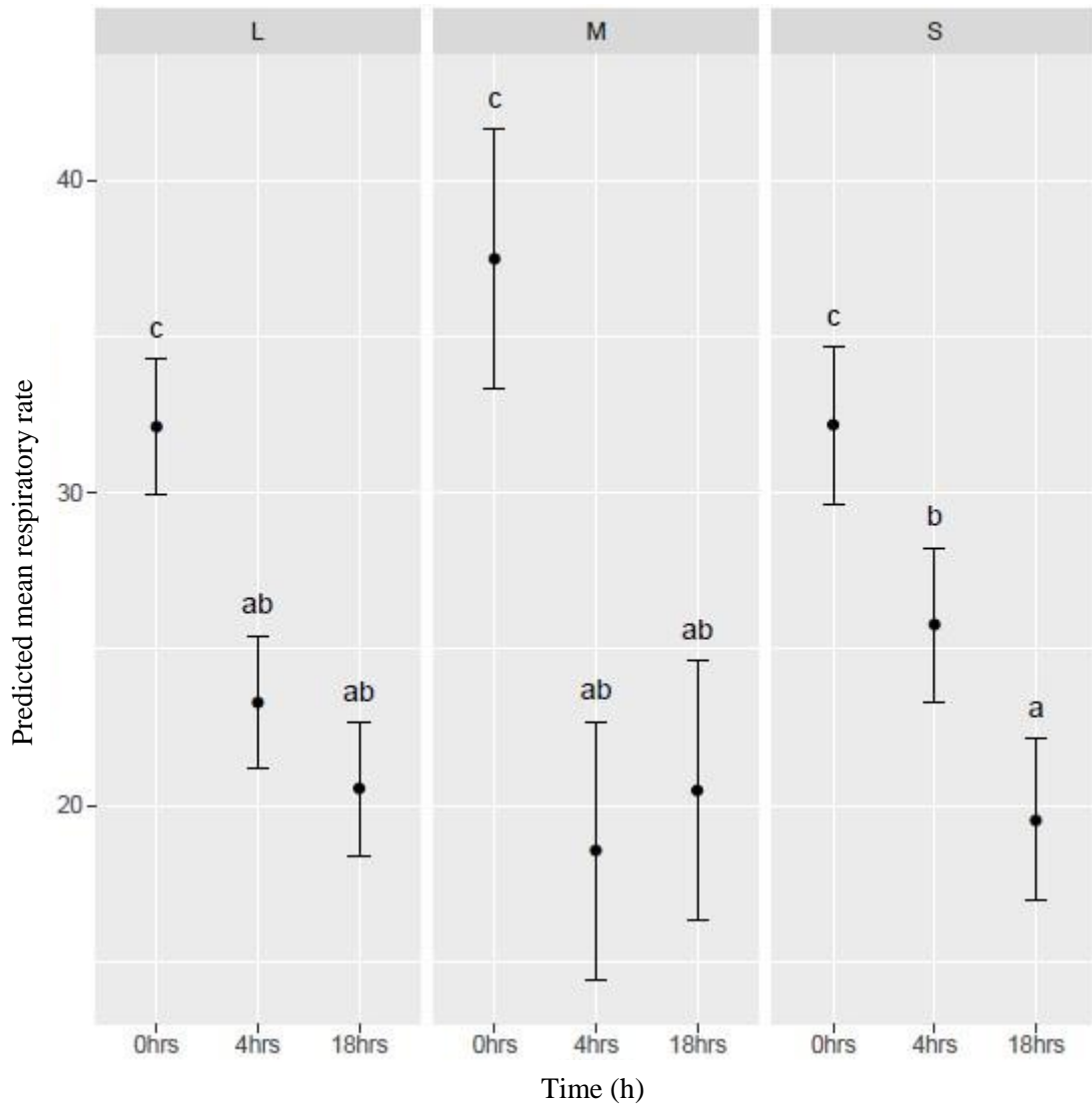


Figure 5.22 Predicted mean respiratory rates for size of hospital: time with standard error

The predicted mean respiratory rate values for the interaction of hours from admission to NIV commencement and time are shown in Table 5.22.

Table 5.22 Predicted mean respiratory rates according to hours from admission to NIV commencement: time (standard error of prediction)

Hours from admission to NIV commencement	Time		
	0 hours	4 hours	18 hours
0	34.33 (0.93)	21.79 (0.93)	19.41 (0.94)
2	34.11 (0.89)	22.19 (0.88)	19.82 (0.90)
4	33.90 (0.90)	22.59 (0.90)	20.24 (0.91)
6	33.68 (0.97)	22.99 (0.97)	20.65 (0.98)
8	33.46 (1.08)	23.39 (1.08)	21.07 (1.09)
10	33.24 (1.23)	23.79 (1.23)	21.48 (1.24)
12	33.02 (1.40)	24.18 (1.40)	21.90 (1.41)
14	32.80 (1.58)	24.58 (1.58)	22.32 (1.59)
16	32.58 (1.78)	24.98 (1.78)	22.73 (1.78)
18	32.36 (1.98)	25.38 (1.98)	23.15 (1.99)
20	32.14 (2.19)	25.78 (2.19)	23.56 (2.19)
22	31.92 (2.40)	26.18 (2.40)	23.98 (2.40)
24	31.71 (2.61)	26.58 (2.61)	24.40 (2.62)
26	31.49 (2.83)	26.97 (2.83)	24.81 (2.83)
28	31.27 (3.05)	27.37 (3.04)	25.23 (3.05)
30	31.05 (3.27)	27.77 (3.26)	25.64 (3.27)
32	30.83 (3.49)	28.17 (3.48)	26.06 (3.49)
34	30.61 (3.71)	28.57 (3.70)	26.47 (3.71)
36	30.39 (3.93)	28.97 (3.93)	26.89 (3.93)
38	30.17 (4.15)	29.37 (4.15)	27.31 (4.15)

Table 5.22 shows that patients who had NIV commenced earlier, had higher respiratory rates at zero hours. The lower the number of hours between presentation and NIV commencement, the lower the patients' predicted mean respiratory rate was at 18 hours. The longer the time between presentation and NIV commencement, the smaller the difference between the 0-hour and 18-hour predicted mean respiratory rate. The predicted mean respiratory rates decreased consistently across the time points at each two-hour interval from presentation to NIV commencement. A graph of the mean respiratory rate values for hours from admission to NIV commencement: time is presented in Figure 5.23.

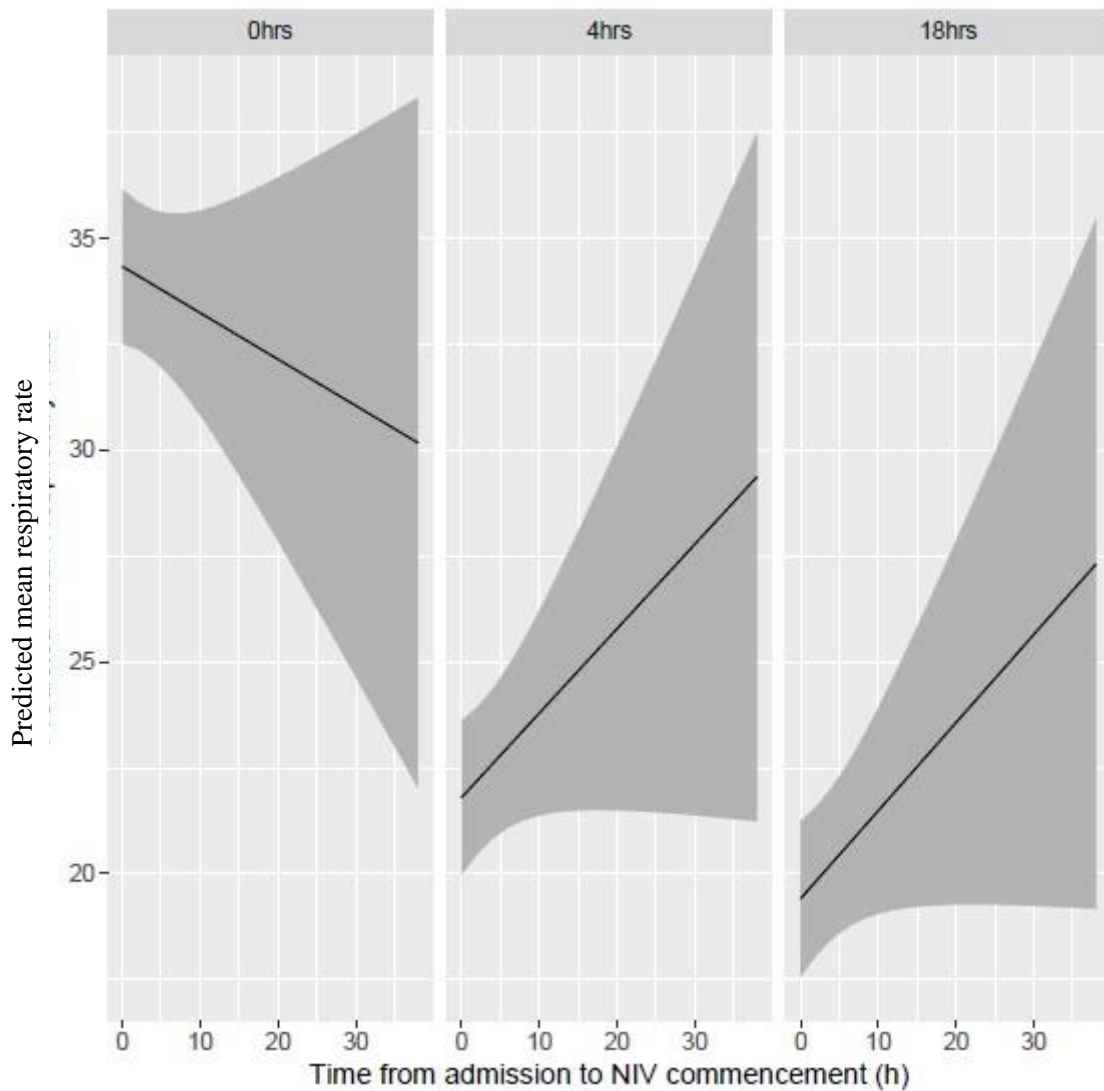


Figure 5.23 Predicted mean respiratory rate for hours from admission to NIV commencement: time with standard error

At the conclusion of the analysis of the short- and medium-term outcomes (pH, pCO₂ and respiratory rate) the longer-term outcomes including ICU length of stay, hospital length of stay and mortality were examined. The results of these analyses are presented below.

5.5.4 Analysis of ICU Length of Stay

The first analysis focused on ICU length of stay and examined the effect of NIV on this outcome. The data for this analysis are only relevant for patients who were transferred to ICU. Therefore, records for patients not admitted to ICU were not included in this analysis. The data for ICU length of stay are not a repeated measure therefore the following analysis used a different model from that used for pH, pCO₂ and respiratory rate. A linear mixed model using restricted maximum likelihood was used to analyse the data using ASReml in

R (Butler, 2009). The analysis of variance for NIV and ICU length of stay is shown in Table 5.23.

Table 5.23 Analysis of variance for ICU length of stay

Model term	Numerator degrees of freedom	F	<i>p</i>
NIV	1	5.84	.022

Table 5.23 shows there is a significant effect on ICU length of stay due to NIV. The predicted mean ICU length of stay for NIV with rankings were then examined. These are presented in Table 5.24.

Table 5.24 Predicted mean ICU length of stay for NIV (standard error of prediction)

Model term	NIV	No NIV
ICU length of stay	114.163 (16.461) ^b	51.791 (24.055) ^a

Note: Rankings are interpreted by reading across rows. Different letters represent a 5% significant difference between the means

Table 5.24 shows the predicted mean ICU length of stay for patients who received NIV compared to patients who did not receive NIV. The patients who received NIV had a significantly longer ICU length of stay compared to those who did not receive NIV. This effect is shown graphically in Figure 5.24.

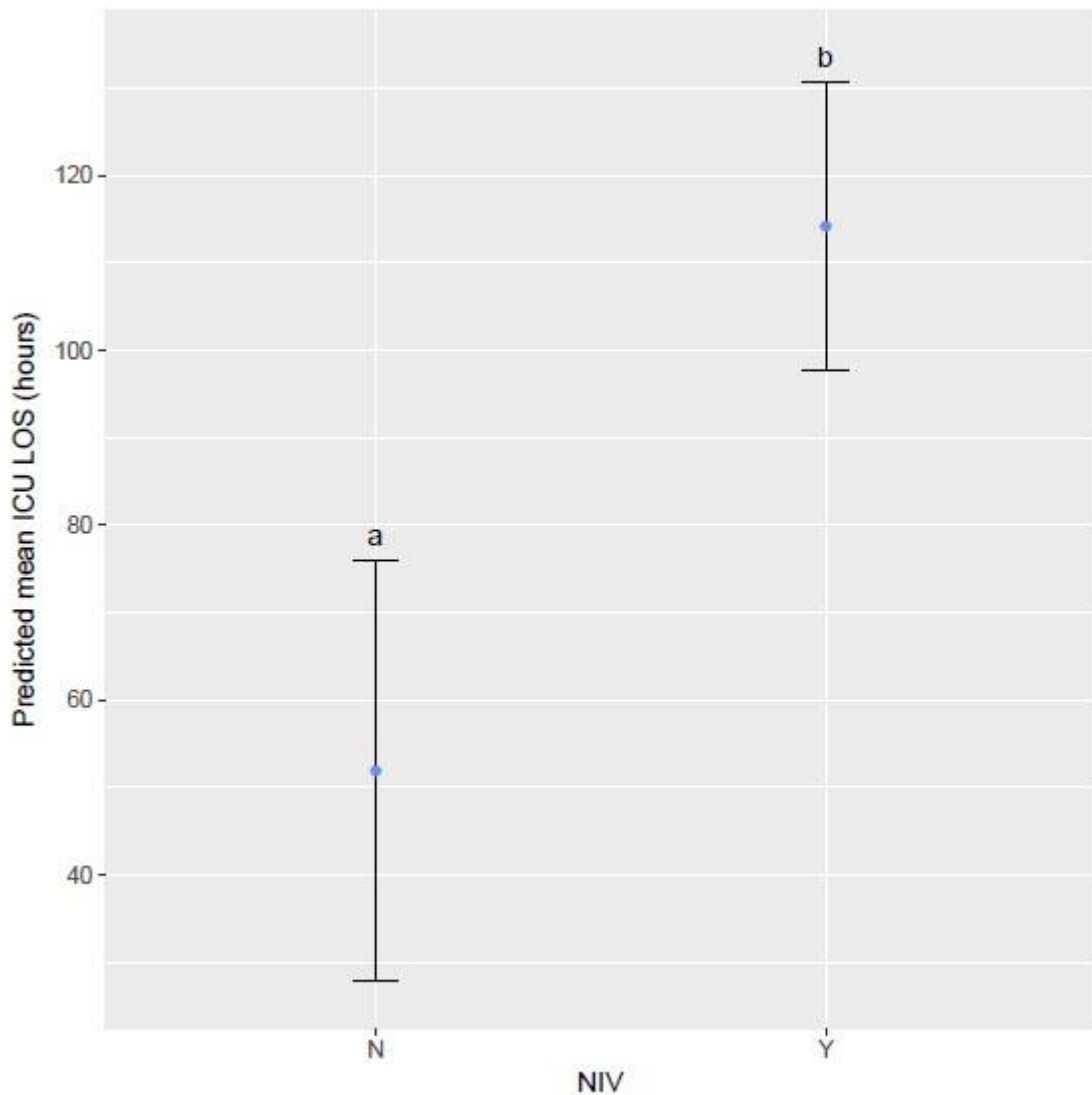


Figure 5.24 Predicted mean ICU length of stay for NIV treatment with standard error

The next analysis considered the effect of covariates on ICU length of stay in relation to NIV. A linear mixed model using restricted maximum likelihood was used to analyse the data using ASReml in R (Butler, 2009). The covariates tested in the model were:

- size of hospital
- age
- sex
- COPD
- smoking
- allergies
- spirometry
- hours from admission to NIV commencement

- total NIV hours
- need for intubation
- intubated on day number
- invasive ventilation hours
- hospital length of stay and
- inter-hospital transfer.

The analysis of variance for the covariates in the ICU length of stay analysis is shown in Table 5.25.

Table 5.25 Analysis of variance for ICU length of stay

Model terms	Numerator degrees of freedom	F	<i>p</i>
NIV	1	18.85	< .001
Invasive ventilation hours	1	60.51	< .001
Total NIV days	1	35.24	< .001
COPD	1	8.37	.007

Table 5.25 demonstrates a significant effect due to NIV on ICU length of stay ($p < .001$). There was also a significant effect on ICU length of stay due to the covariates: invasive ventilation hours, total NIV days and COPD ($p < .05$). The predicted mean values for ICU length of stay according to the significant covariates were then examined. Table 5.26 shows the predicted mean values for ICU length of stay for COPD.

Table 5.26 Predicted mean values of ICU length of stay for COPD (standard error of prediction)

Model term	COPD	No COPD
ICU length of stay	245.7 (22.9) ^b	195.5 (13.6) ^a

Note: Rankings are interpreted by reading across rows. Different letters represent a 5% significant difference between the means

Table 5.26 shows that the predicted mean ICU length of stay for patients who had a concurrent diagnosis of COPD was significantly longer than for patients without a concurrent diagnosis of COPD ($p < .05$). This effect is shown graphically in Figure 5.25.

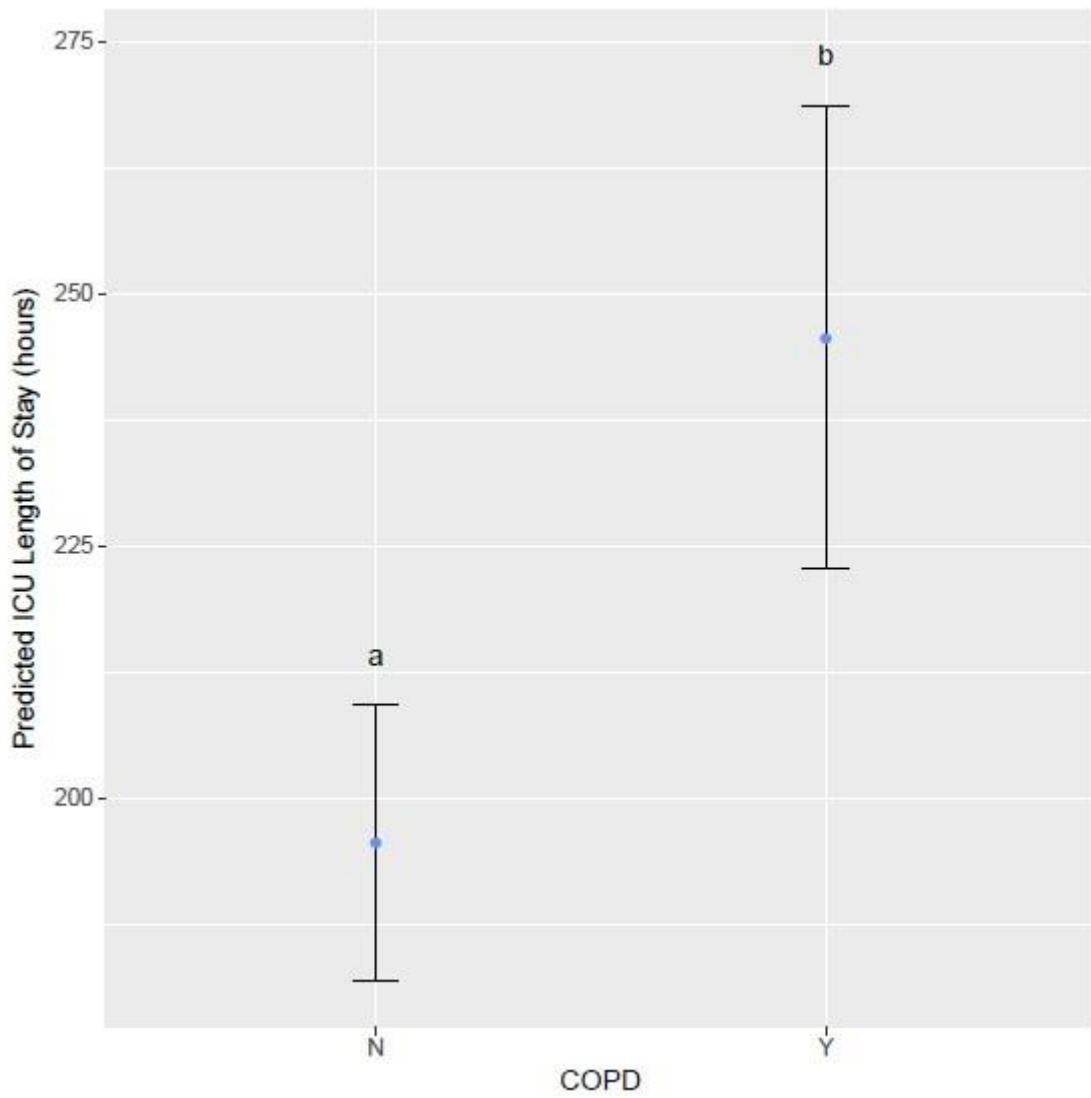


Figure 5.25 Predicted mean ICU length of stay for COPD with standard error

The predicted values of ICU length of stay for the covariate total NIV days was next examined. Table 5.27 shows the predicted value of ICU length of stay as total NIV days increased.

Table 5.27 Predicted mean values of ICU length of stay for total NIV days (standard error of prediction)

Total NIV days	Predicted mean ICU length of stay
0.0	174.621 (13.433)
0.5	188.616 (14.158)
1.0	202.612 (15.154)
1.5	216.607 (16.371)
2.0	230.602 (17.765)
2.5	244.597 (19.296)
3.0	258.592 (20.936)
3.5	272.587 (22.660)
4.0	286.582 (24.450)
4.5	300.577 (26.293)
5.0	314.572 (28.179)
5.5	328.567 (30.100)
6.0	342.562 (32.048)
6.5	356.557 (34.021)
7.0	370.553 (36.013)

Table 5.27 demonstrates that as the number of total NIV days increased, the predicted mean ICU length of stay also increased. The linear regression line relating total NIV days and ICU length of stay (hours) is:

$$\text{ICU length of stay (hours)} = 39.703 + 27.986 \times \text{total NIV days}$$

This can be interpreted – for every NIV day the length of stay in ICU increases by 28.0 hours. This is shown graphically in Figure 5.26.

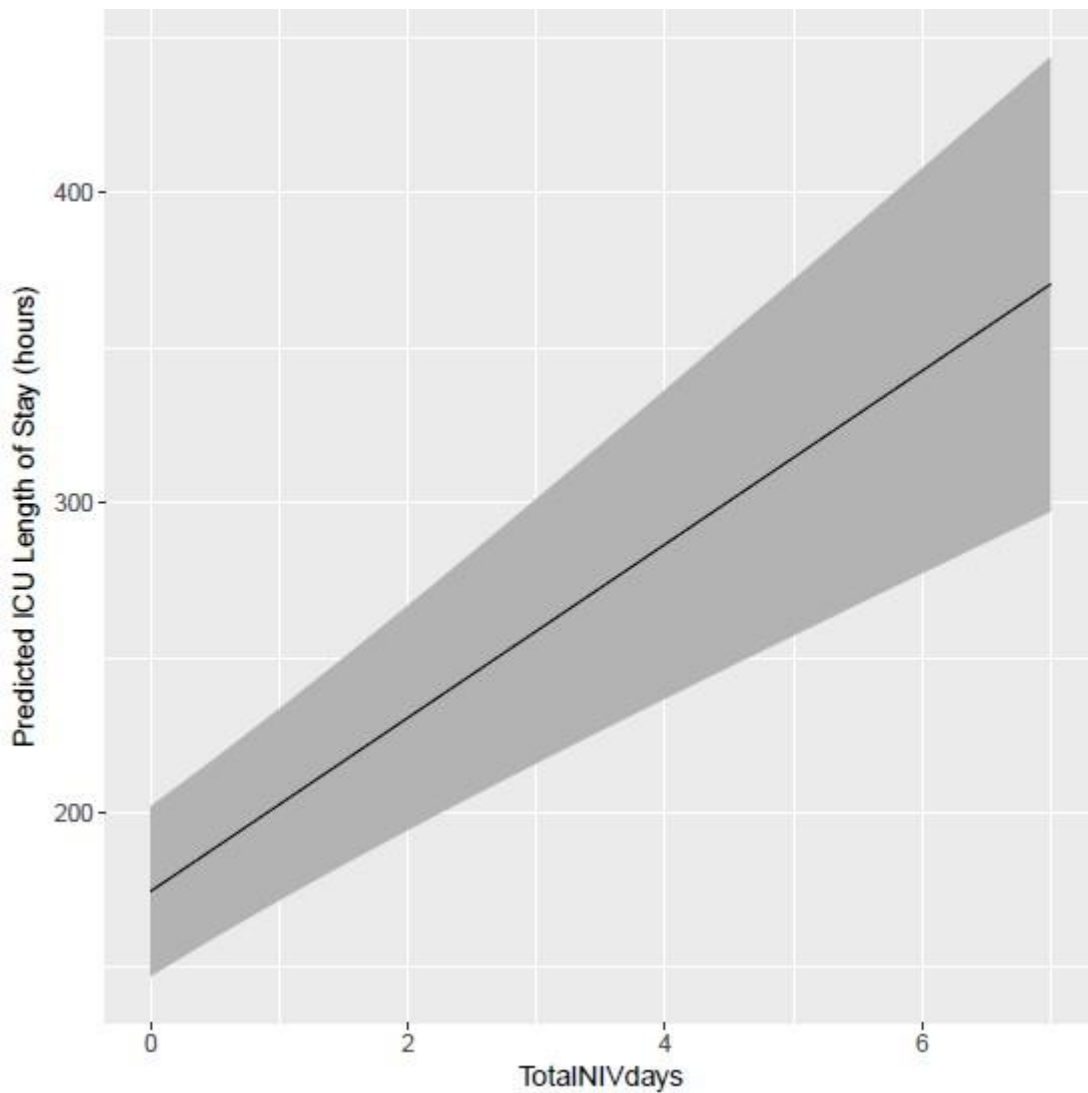


Figure 5.26 Predicted ICU length of stay for total NIV days with standard error

The predicted mean values of ICU length of stay were then examined for invasive ventilation hours. These are shown in Table 5.28.

Table 5.28 Predicted mean values of ICU length of stay for invasive ventilation hours (standard error of prediction)

Invasive ventilation hours	Predicted mean value of ICU length of stay
25	128.146 (10.938)
45	152.239 (12.054)
65	176.333 (13.507)
85	200.427 (15.201)
105	224.520 (17.065)
125	248.614 (19.049)
145	272.708 (21.119)
165	296.801 (23.252)
185	320.895 (25.432)

Table 5.28 shows that as the number of invasive ventilation hours increases, the predicted mean of ICU length of stay also increases. The linear regression line relating total invasive ventilation hours and ICU length of stay (hours) is

$$\text{ICU length of stay (hours)} = 39.703 + 1.205 \times \text{invasive ventilation hours}$$

This can be interpreted – for every hour with invasive ventilation the length of stay in ICU increases by 1.2 hours. This is shown graphically in Figure 5.27.

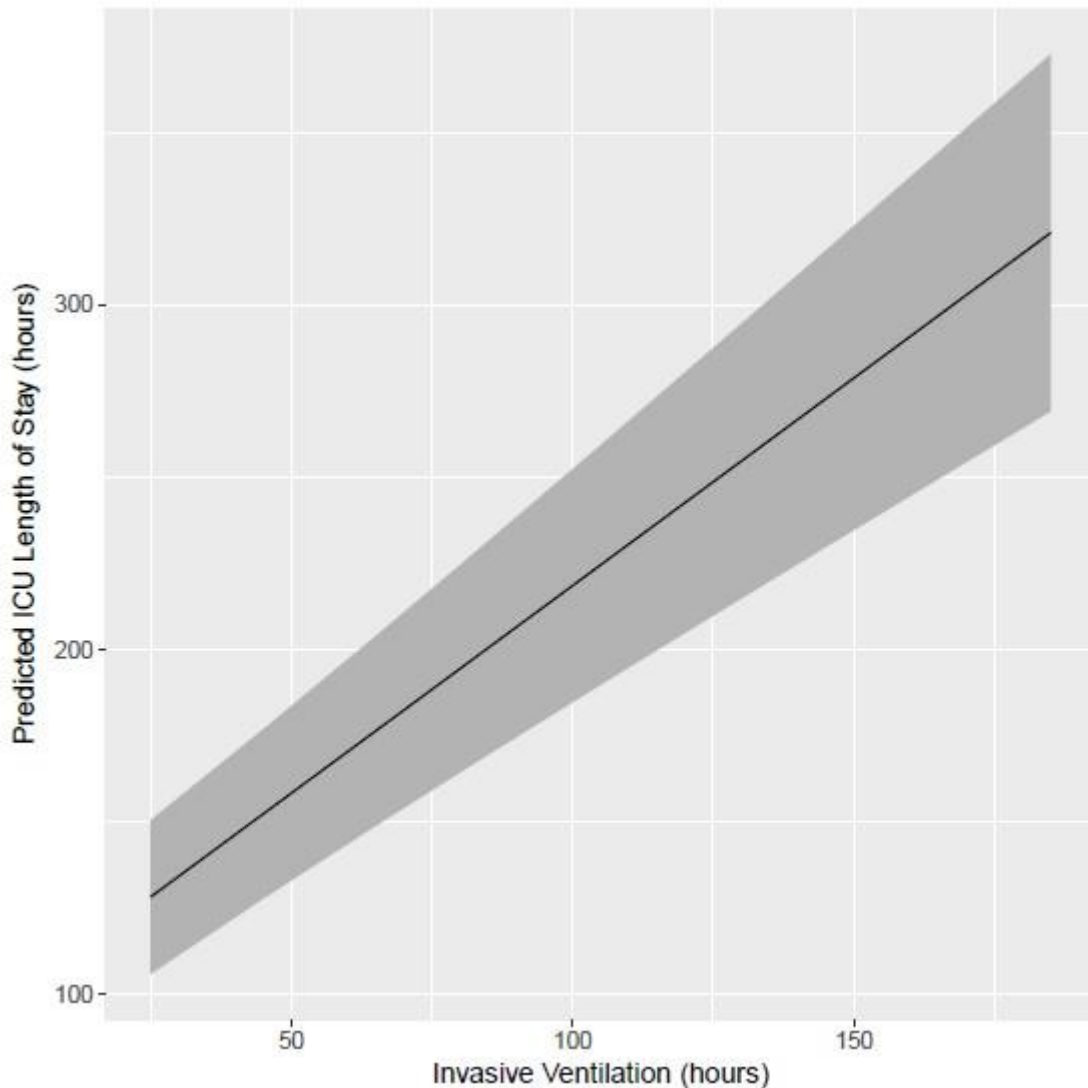


Figure 5.27 Total invasive ventilation days and ICU length of stay with standard error

5.5.5 Analysis of Hospital Length of Stay

As with the analysis for ICU length of stay, the data for hospital length of stay are not a repeated measure therefore the following analysis uses a different model from that used for pH, pCO₂ and respiratory rate. A linear mixed model using restricted maximum likelihood

was used to analyse the data using ASReml in R (Butler, 2009). Table 5.29 shows the analysis of variance results for hospital length of stay.

Table 5.29 Analysis of variance for hospital length of stay

Model term	Numerator of freedom	degrees	F	<i>p</i>
NIV	1		12.11	.001

Table 5.29 shows that NIV did have a significant effect on hospital length of stay ($p < .05$). The predicted values for hospital length of stay according to NIV are shown with rankings in Table 5.30.

Table 5.30 Predicted value of hospital length of stay according to NIV (standard error of prediction)

Model term	NIV	No NIV
Hospital length of stay	7.000 (0.591) ^b	3.545 (0.797) ^a

Note: Rankings are interpreted by reading across rows. Different letters represent a 5% significant difference between the means

Table 5.30 shows that patients who received NIV had a significantly longer hospital length of stay compared to patients who did not receive NIV ($p < .05$). This is presented graphically in Figure 5.28.

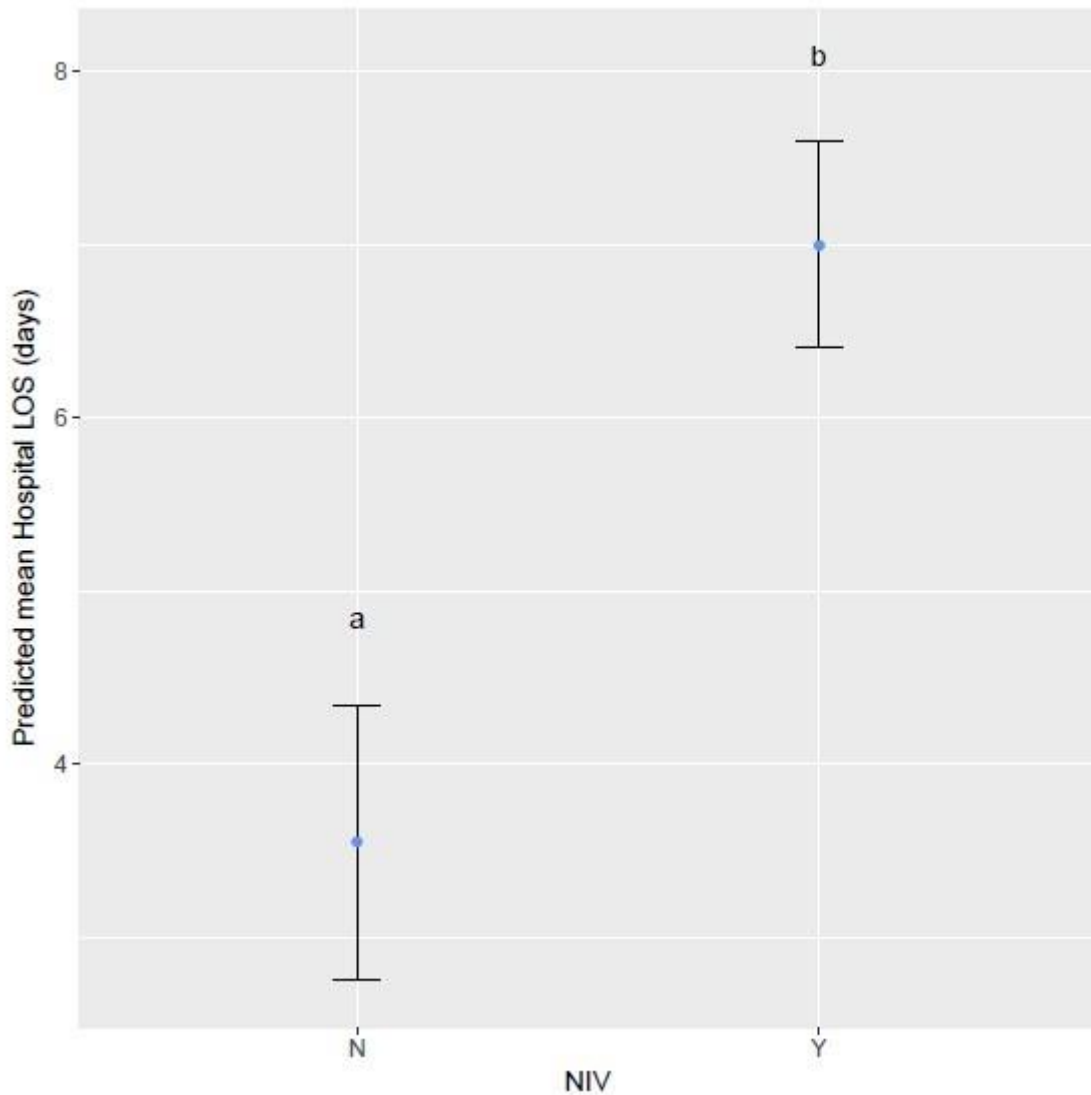


Figure 5.28 Predicted mean hospital length of stay and NIV treatment with standard error

A covariate analysis was then conducted to determine if any of the covariates had a significant effect on hospital length of stay. A linear mixed model using restricted maximum likelihood was used to analyse the data using ASReml in R (Butler, 2009). The covariates included in the model were:

- size of hospital
- age
- sex
- COPD
- current smoking
- allergies
- spirometry

- hours from admission to NIV commencement
- total NIV hours
- need for intubation
- intubated on day number
- invasive ventilation hours
- ICU
- ICU length of stay (hours) and
- inter-hospital transfer.

Table 5.31 shows the analysis of variance results for the covariate analysis.

Table 5.31 Analysis of variance for hospital length of stay

Model terms	Numerator degrees of freedom	F	<i>p</i>
NIV	1	22.55	< .001
Need for intubation	1	23.49	< .001
Total NIV hours	1	21.56	< .001
Sex	1	5.54	.022
Inter-hospital transfer	1	5.16	.027

Table 5.31 shows there was a significant effect due to NIV, need for intubation and total NIV hours on hospital length of stay ($p < .001$). There was also a significant effect on hospital length of stay due to sex and inter-hospital transfer ($p < .05$). The predicted values for these covariates were then examined. The predicted values and rankings of hospital length of stay (hours) according to the need for intubation and inter-hospital transfer are shown in Table 5.32.

Table 5.32 Predicted mean values of hospital length of stay according to need for intubation and inter-hospital transfer (standard error of prediction)

Model terms	Yes	No
Need for intubation	12.0 (1.4) ^b	4.8 (0.5) ^a
Inter-hospital transfer	7.9 (1.2) ^b	5.4 (0.6) ^a

Note: Rankings are interpreted by reading across rows. Different letters represent a 5% significant difference between the means

Table 5.32 shows that there was a significant effect of the need for intubation on hospital length of stay. Patients who required intubation had a predicted mean hospital length of stay of 12 days compared to 4.8 days for those who were not intubated. Inter-hospital transfer also had a significant effect on hospital length of stay. Patients who required an inter-hospital transfer had a predicted mean hospital length of stay of 7.9 days compared to 5.4 days for

those who did not require inter-hospital transfer. Figures 5.29 and 5.30 show these data graphically.

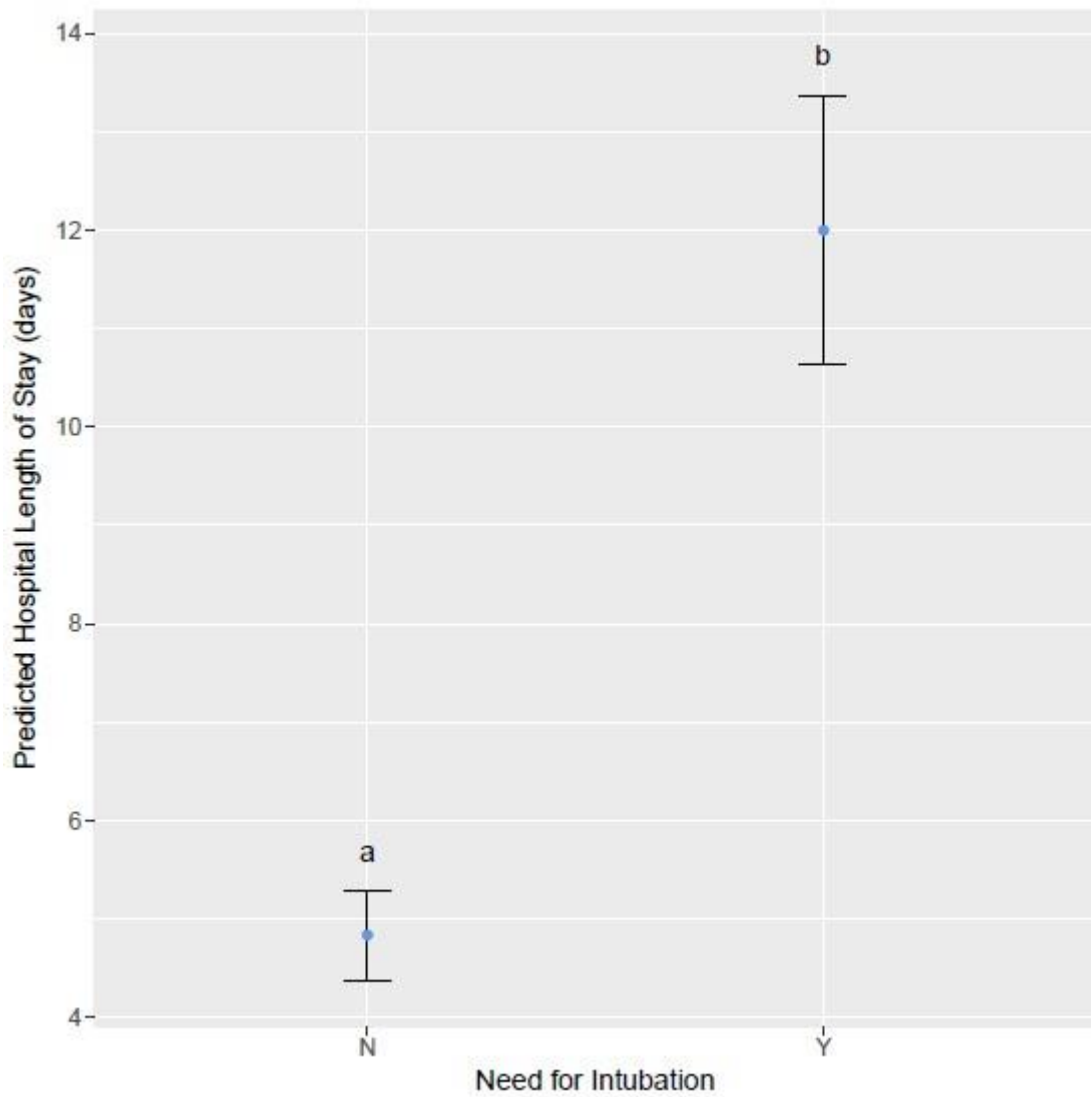


Figure 5.29 Predicted mean hospital length of stay (days) according to need for intubation with standard error

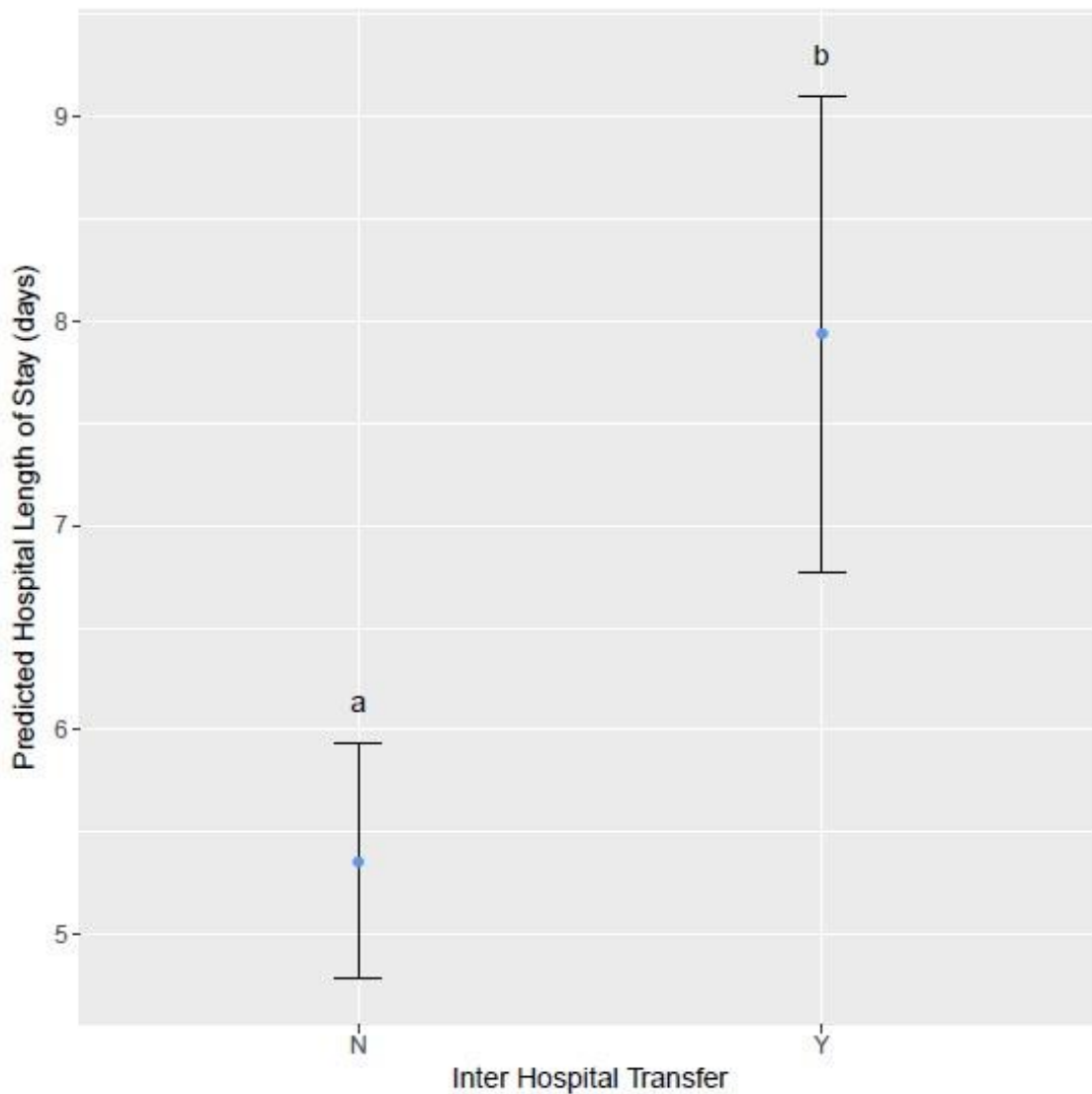


Figure 5.30 Predicted mean hospital length of stay (days) according to inter-hospital transfer with standard error

The predicted mean values and rankings of hospital length of stay for each sex were then examined and are shown in Table 5.33.

Table 5.33 Predicted mean value of hospital length of stay according to sex (standard error of prediction)

Model term	Female	Male
Sex	6.5 (0.6) ^b	4.4 (0.8) ^a

Note: Rankings are interpreted by reading across rows. Different letters represent a 5% significant difference between the means

Table 5.33 demonstrates that patients' sex had a significant effect on hospital length of stay. Females had a predicted mean hospital length of stay of 6.5 days compared to 4.4 days for males. The effect of sex on hospital length of stay is shown graphically in Figure 5.31.

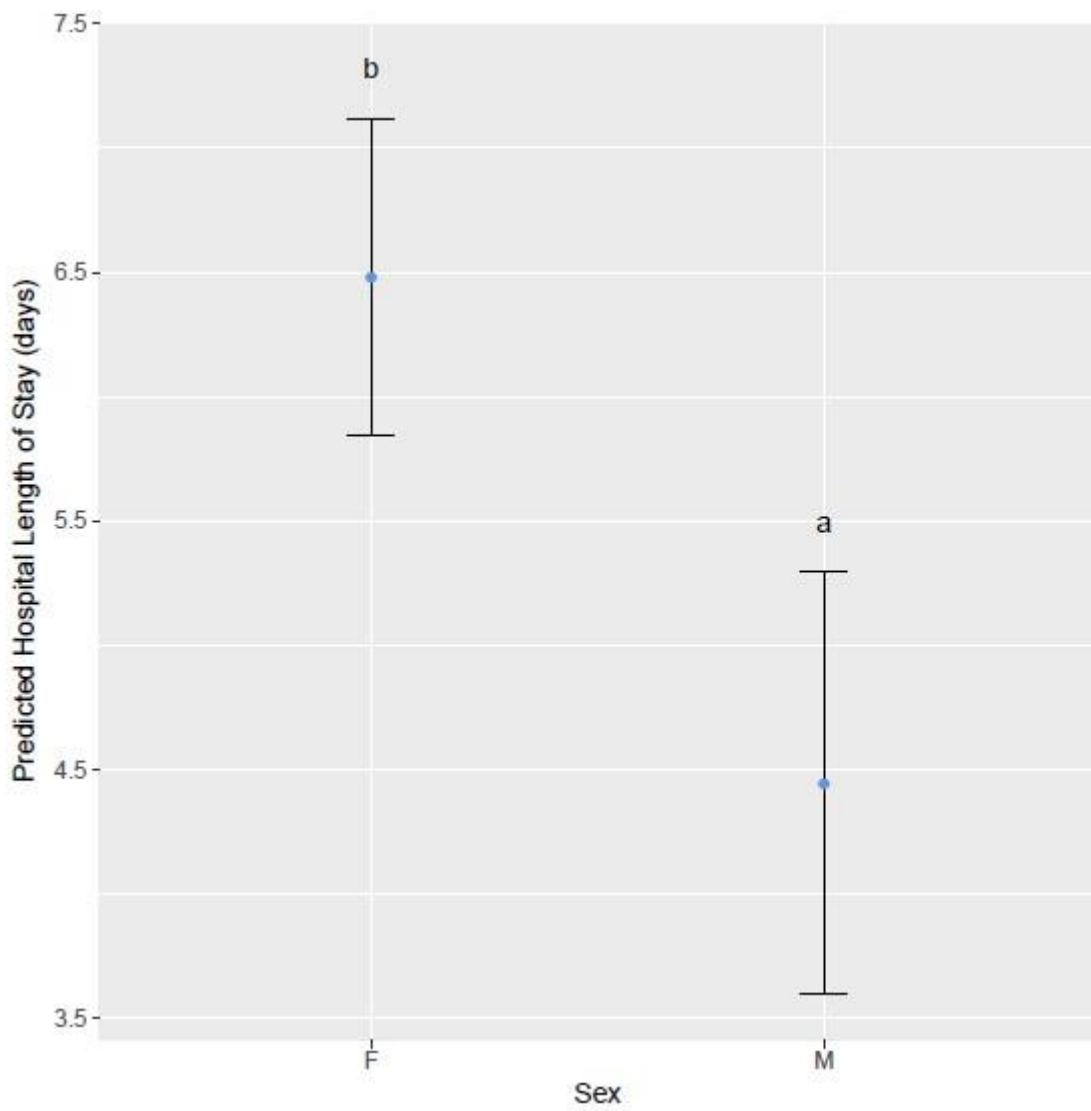


Figure 5.31 Predicted mean hospital length of stay (days) according to sex with standard error

Finally, the predicted mean hospital length of stay according to total NIV hours was examined. These values are shown in Table 5.34.

Table 5.34 Predicted mean hospital length of stay according to total NIV hours (standard error of prediction)

Total NIV hours	Predicted value of hospital LOS
0	4.756 (0.551)
10	5.199 (0.486)
20	5.642 (0.520)
30	6.085 (0.635)
40	6.527 (0.799)
50	6.970 (0.986)
60	7.413 (1.187)
70	7.856 (1.394)
80	8.298 (1.606)
90	8.741 (1.821)
100	9.184 (2.038)

Table 5.34 shows that as the total hours of NIV increased the predicted mean hospital length of stay also increased. The linear regression line relating total NIV hours and hospital length of stay is

$$\text{Hospital length of stay (days)} = 3.545 \times \text{total NIV hours}$$

This can be interpreted – for every hour on NIV, the length of stay in hospital increases by 3.5 hours. This is represented graphically in Figure 5.32.

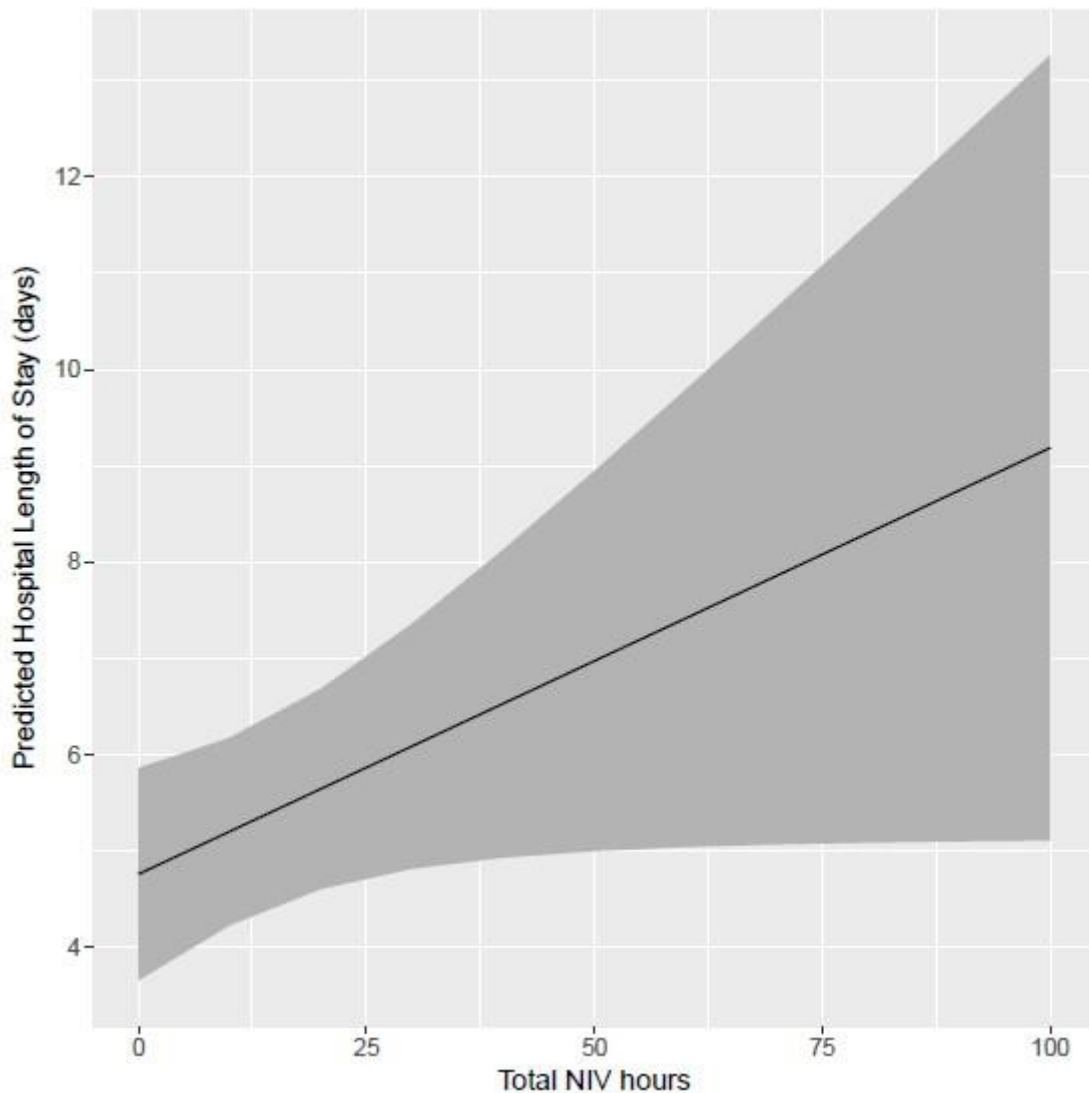


Figure 5.32 Predicted mean hospital length of stay (days) and total NIV hours with standard error

5.5.6 Analysis of Mortality

The final long-term outcome examined was survival to hospital discharge. In both the NIV and no NIV group there was 100% survival to hospital discharge. As there was no mortality in either group, statistical analysis of the effect of NIV on mortality rates was unable to be conducted.

5.6 Chapter Summary

This chapter has examined the quantitative data analysis that was conducted to answer the first three research questions. It was determined that of the 71 patients eligible for NIV in the allocated study period, 63% actually received NIV treatment. The most common type of

NIV used to treat patients in this study was BiPAP. Large hospitals (> 200 beds) were statistically more likely to use NIV as a treatment compared to medium (50–200 beds) and small (< 50 beds) hospitals but there was no significant relationship between individual hospitals and the likelihood NIV would be used. In regards to the analysis of the short-term outcomes, NIV did not have a significant effect on pH or pCO₂. It did have a significant effect on respiratory rate but on examination of the predicted values this effect may have been due to the interaction of time and NIV rather than NIV itself. NIV had a significant effect on ICU length of stay and hospital length of stay. There was no mortality in either group so an analysis of the effect of NIV on mortality could not be conducted. Following on from the quantitative results, the next chapter will examine the data that were obtained from the qualitative interviews to provide the experiential account of the nurses using NIV.

Chapter 6: Qualitative Results

6.1 Introduction

This chapter presents the findings of the qualitative phase of this research project. This phase of the project was conducted to further explore the quantitative findings. The participants will be briefly introduced before the results of the interviews are outlined according to the themes that were identified in the analysis. There were two phases of thematic analysis: the first phase presents a model which incorporates multiple codes. These were then allocated to themes which formed eight major steps on the path to clinical intuition which will be discussed in detail. The stages are: the introduction of new technology into practice, education, isolation, fear, support and mentorship, taking ownership, leadership and intuition. Following thematic discussion there will be a discussion of the movement of the nurses on the path to clinical intuition. As a critical care nurse, the researcher will reflect on the data and provide comment on her personal interaction with the data.

6.2 Introducing the Participants

The participants were all nurses currently employed in an ED or ICU where NIV is used as a treatment for acute exacerbations of asthma. The nurses who were interviewed responded to a flyer that was distributed to staff eligible to participate. All interviews occurred on hospital grounds at a mutually convenient time and were conducted as individual, semi-structured interviews, as outlined in Chapter 4. There was a total of nine interviews conducted. Table 6.1 provides information specific to each participant. Column five labelled 'Specialty area' refers to the area in which the nurse was employed at the time the interview was held. Column six labelled 'Number of years in current position' refers to the number of years the nurse has been employed in the position they were working in at the time of the interview. The final column labelled 'Classification level' refers to the number of years the nurse has been registered. Note that after eight years the nurse remains a RN level 8 as this is the highest pay grade in the NSW Nurses' Award (Industrial Relations Commission of New South Wales, 2017).

Table 6.1 Participant information

Name	Age	Sex	Hospital	Specialty area	Number of years in current position	Classification level
Caitlin	40	F	Regional	ICU	12	RN 8
Cindy	51	F	Rural	ED	6	RN 8
Darren	29	M	Regional	ED/ICU	3	RN 3
Emily	44	F	Rural	ED	14	RN 8
Jess	41	F	Rural	ED	4	RN 8
Kat	45	F	Regional	ICU	4	RN 4
Lauren	31	F	Regional	ICU	11	RN 6
Lochlan	31	M	Regional	ICU	7	RN 8
Tilly	59	F	Rural	ED	6	RN 8

6.3 Development of the Interview Questions

The stated purpose of conducting the qualitative phase of this project was to provide context and depth to the quantitative results. Due to this, the questions the participants were asked in the interviews were modelled from the quantitative findings that were outlined in Chapter 5. It should be noted that the interviews were conducted in a semi-structured fashion and due to this, the participants contributed data that were in addition to that sought by the researcher. In keeping with the philosophical assumptions outlined in Chapter 3, all information provided by the participants was treated as their own truth. The experiential data were seen to have equal weight to the external data collected for quantitative purposes. Table 6.2 shows the origin of the qualitative interview questions in relation to the quantitative result.

Table 6.2 Quantitative origins of the qualitative interview questions

Quantitative findings	Qualitative explorations
Not all patients with acute asthma who met the criteria for NIV received the treatment. There may be contextual reasons for this related to the staff who prescribe and use NIV such as their experiences and use of guidelines.	How were you introduced to NIV? How did the way you were introduced to NIV make you feel? Who makes the decision to treat a patient with NIV? Is the decision to use NIV based on guidelines? Who changes the NIV settings? Are doctors responsive to being questioned by nurses? What have your experiences been like when using NIV? Have you had any particularly good or bad experiences?
The use of NIV fluctuated across years and facilities. This may have been a result of staff education, staff turnover, skill mix and isolation.	Are there any particular factors that influence or inhibit your use of NIV? Tell me about influences on your nursing practice such as your team, skill mix and shifts. How did you learn to use NIV? Do you receive ongoing support to improve your education in NIV? How do you feel about self-initiating education? How do you think other nurses feel about self-initiating education?
Across the LHD under study NIV was used in critical care areas but the researcher also became aware of its use in general ward areas.	Do you ever treat patients on the wards with NIV? Do you think patients on NIV should be treated on the ward?
The small hospitals were significantly less likely to use NIV. This may have been attributable to the experiences and education of the staff. It was also possible that exposure to using NIV affected the confidence of clinicians to use the treatment.	How often do you think you would use NIV on average in one year? Are you comfortable using NIV? Why/why not?

6.4 Development of the Themes

At the conclusion of the interviews, each recording was transcribed by an employed transcription specialist, in draft format. The researcher then used the audio tapes to edit the interviews until they were accurate and prepared for analysis. This occurred as soon as each interview was conducted. The interviews were between 30 and 60 minutes in length. The themes analysed in this research project were developed according to the model suggested by

Braun and Clarke (2006). This process involved the generation of initial codes, searching for themes, reviewing themes and defining and naming themes. Coding commenced as soon as the transcripts were completed, while interviews were ongoing. This was to ensure the researcher had an ongoing comprehension of the developing themes and could monitor for saturation. Initial codes used were education, fear, increasing confidence, isolation, NIV as a treatment, patient focus, policy and procedure, power and skill mix. After the initial coding of data, information was allocated to themes and subthemes. The themes and subthemes that emerged from the initial coding are shown in the model below. The major themes initially identified from the coded data were power, fear, isolation and education. Each of these themes related to data which were coded as subthemes. Many of the themes were inter-related, as is shown in Figure 6.1.

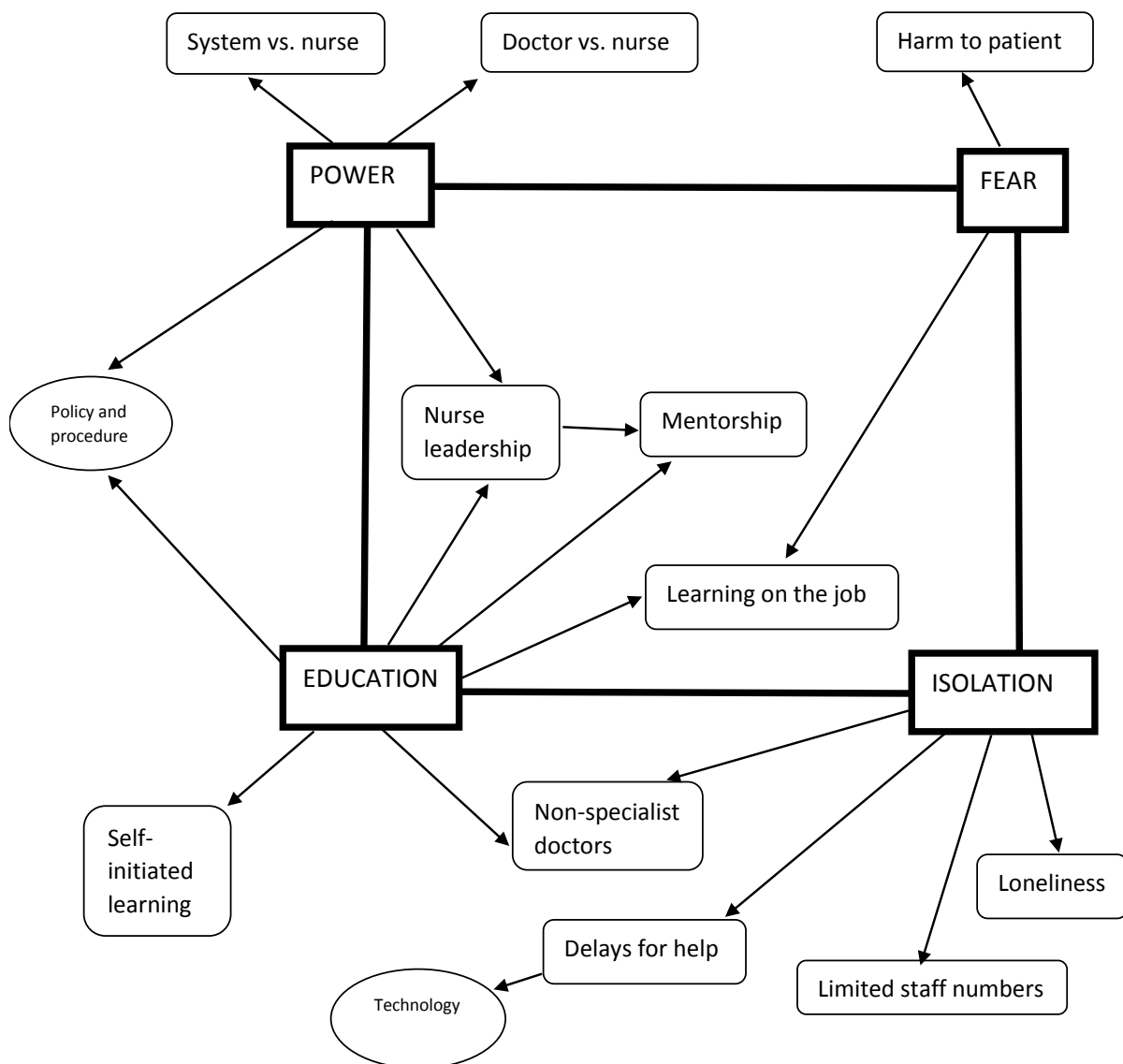


Figure 6.1 Emerging codes from Phase 1 of the qualitative data analysis

Thematic saturation had occurred by the eighth interview but, as the final interview was booked, it was still conducted and included in the analysis. No new themes were identified during this last interview. Once thematic saturation occurred, themes were defined and the interviews reviewed to determine congruence. After the initial allocation of data to themes, the interview transcripts and notes were revisited. The original themes merged into eight distinct points in the nurses' practice. The participants were describing a journey through several stages. Their transition was evident in the way they spoke of their introduction to NIV, their early use of the technology and their current use of NIV. It began with the introduction of the new technology into clinical practice, followed by education, isolation and fear. The nurses then began to support and mentor one another, take ownership over the treatment and their

practice, lead the treatment and use the NIV machine intuitively. These are presented in Figure 6.2 as the major themes described by the nurses.

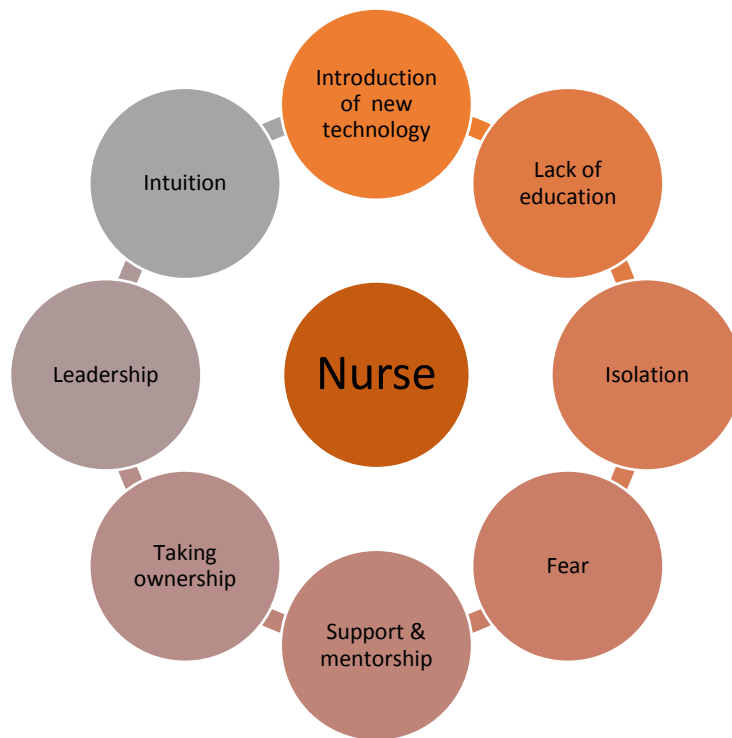


Figure 6.2 Original conception of major themes

6.4.1 Introduction of New Technology into Clinical Practice

When the nurses were asked how NIV was introduced into their facility, the power of the system to dictate practice to them was evident in their answers. This was particularly prevalent in the answers of the nurses from small rural hospitals, possibly because NIV was only introduced in these facilities in the past three years so the nurses had strong recollections of how it occurred in comparison to the regional sites where NIV had been in use for approximately 10 years.

Cindy, a 51-year-old nurse with many years' nursing experience – six of which were as a RN working in a rural ED stated, *'Every [ED] in small rural sites was issued [an NIV machine] and we were to utilise it'*. She said this in a very matter of fact way, as if it was the norm for the facility to inform the nurses what equipment they would and would not use. This was very similar to the answer given by Emily, a senior emergency nurse in a neighbouring rural ED. She answered, *'We didn't want [NIV] and we were told "No – this is the equipment"'. We*

actually asked if it could be taken [away]’. The health service, having already purchased and delivered the equipment, did not take the NIV machine away as was requested by the nurses.

In many instances, although the machine remained, it was not used. In Tilly’s rural facility it was left in the ED, in the corner with a sheet over it. Emily elaborated as to why the NIV machine was not used for such a long period after it had been delivered to her ED. When the NIV machine was initially delivered, the nurses (those who could attend) were given a couple of hours of instruction by the company representative which was the extent of their training on the device. After this initial introduction, Emily said:

The training then was ... if you saw a course and you attended it, not that it came to us. We had to actively seek it out. So, that was what was annoying because we didn’t get any proper training. (Emily)

Jess is also a senior RN working in the ED of a small rural facility. She described very similar circumstances in regards to how NIV was introduced into her facility, *‘This is the [NIV] machine. That’s it. No training, no nothing’*. Despite the equipment being introduced into areas without warning or education, there was still a requirement for nurses to use it. Kat, a fourth-year RN working in an ICU, described such a situation when she was forced to care for a patient on NIV before she had been trained to use it. She had only been working in the unit for two months as a new graduate nurse. Kat recalled:

One day there was no one else to take it, so I was kind of dumped with a NIV patient, with five minutes of “Here you go, this is what you need to look for”, and it was a bit terrifying ... before I even got the patient when we were setting up, and I said “I’m not – you know, this is not within my normal scope. I have not had a patient on NIV before, you know, I don’t know what I’m doing”. And they said “Oh, we’ll explain the machine to you. Here you go”. And spent five minutes and went “You’ll be right” ... I think they thought they could twist my arm, you know, being two months into the [new graduate] program. (Kat)

This shows the vulnerability of newly graduated nurses in some clinical scenarios. Kat was asked if she felt that other nurses would advocate for themselves and their patients in the same way if put in this situation. She replied:

They’d feel like “This is what I’ve been told I have to do”, and therefore, they would do it and they would be scared stupid the whole time and worried about their compromising of the patient and it’s against what they agree for their registration, but they would do it because they would feel pushed and feel like their job is at risk. (Kat)

Lauren had similar feelings about the vulnerability of junior staff using new technology:

We have got a very junior workforce at the moment who are a bit inexperienced and ... obviously haven't had the exposure or the experience to confidently say "Oh, we can apply [NIV] at these settings and we should achieve these outcomes". (Lauren)

Darren, a third-year RN who works in the ED and ICU, described his first introduction to NIV which occurred when he was an enrolled nurse. He was asked to look after a patient on NIV, something he had never done before. He said:

On reflection, knowing what I know now, no way in hell I'd do that ever again, and ... there is no way that I'd expect other people to do that, to the point that I think it's derived from this culture in nursing where we eat our own and I'm one massive advocate, I hate it, I hate it because it is ingrained from yesteryear, from yesteryear those junior nurses are our current management and I hate it. (Darren)

The introduction of new technology into clinical practice therefore had many negative connotations for the nurses. New technology was forced upon them when the NIV machines arrived and they were forced to incorporate the use of the new machines into their practice before they were taught how to use them. Many of the nurses raised the issue of lack of education during the implementation of new technology. Education was something they valued and therefore they felt betrayed that it was not provided. This lack of education is discussed as the next theme.

6.4.2 Lack of Education

As the nurses continued with their stories it was evident they were upset about the low level of education provided before they were required to use NIV. They were given no ongoing training and limited funding to attend training outside of the hospital in which they were employed. This was evident in both the small and large sites. Cindy, from a rural site stated, *'None of the staff have had any funding to actually do that NIV [study day]. I don't think there is enough support for education'*.

Jess, also from a rural site, was asked if her facility offered ongoing training for staff. She replied that the only assistance she received was when she called the regional ICU for support. Similarly, Lauren, a senior intensive care nurse and educator from a large referral hospital stated, *'No we don't really have any ongoing training, personally'*.

The implications of providing care to patients using equipment they had not been trained for was discussed by several of the nurses. Kat described this type of experience as a, *'Trial by*

fire'. This description of the reality of using lifesaving equipment for the first time on a patient resonated with many of the other nurses. Cindy, a senior nurse and clinical educator, described her first experience with NIV. She talked about her lack of knowledge with the equipment. Cindy went on to describe her current use of the machine and acknowledged she still had much to learn, *'When I first started to use [NIV] I didn't know much about it ... still – I'm not quite sure what I'm meant to be doing with it'*.

Lochlan, a senior intensive care nurse, reflected on his first experience with NIV and said, *'I was sort of completely ignorant about [NIV] when I first learnt*. He went on to say that he had not only experienced this himself, but had also seen others put in similar situations, *'I've seen situations where nurses with very little training on it have been asked to watch a patient [on NIV]'*. Emily described learning to use NIV in the same way as Lochlan. She was a 44-year-old nurse who had been working for over 14 years and spent almost all of that time working in the ED in a small facility. She described using the NIV machine for the first time even though, *'We didn't get any proper training'*.

As a result of the nurses using equipment they had not been trained for, many of them described their knowledge of NIV when they began to use it as very basic and context-free. This resonated in Lochlan's description of his first use of NIV. He talked about learning to use NIV in a situation where he was unaware of the mechanisms of NIV as a therapy and how it would affect his patient. He was told that by watching only two biometric numbers he would know if the patient was deteriorating. He also described this event as something that he had seen happen to other nurses. He said, *'It wasn't a very structured training. It was, "Here's what it is and these are the two numbers you need to know"'*. Darren underwent the same context-free learning where he was simply told which numbers to watch and not what they meant. He was a new RN at the time and described being, *'... basically told at the time to ... watch the patient's respiratory rate and sats [oxygen saturations] and if that was all okay, then ... that was all okay'*. The nurses now recognise that this was not an appropriate way to learn how to use NIV. Judging a patient's status using only two biometric parameters does not account for all the other subtle changes in a patient when they are deteriorating, which leaves the nurse open to mistakes.

When reflecting on their first use of NIV and the way they were taught to use the machine, several of the nurses recognised that in hindsight they did not have enough knowledge of the technology to use it effectively. They described their NIV training as a type of sink or swim

mentality. Lochlan mentioned this when he described the way he was taught to use the NIV, *'The educator chucked me in the deep end a bit when we started, which was just a way of teaching'*. Lauren also commented that the previous educator just threw her in the deep end. Reflecting on the way she had learnt to use NIV, Kat commented she *'... wouldn't want other nurses to go through that trial by fire type of idea'*. Kat went on to discuss the implications of her *'Trial by fire'* on her patient:

I don't think that [the patient] was given optimal care and the fact that I was so new at doing [NIV] and I wasn't giving optimal care from the fact that I didn't know enough ... All these things that I look back and go, "Oh man, she [the patient] is lucky she pulled through that". (Kat)

The participants gave varying reasons for why education was not available to them. Darren felt that, *'Formal education is tailored towards ... junior nurses'*. He also added, *'We don't have a nursing culture of education'*. However, he believed this was not the only barrier for nursing education:

I think our nursing's getting harder ... the demand on the acute care sector is massive ... health care is not cost effective and ... all of these things are impacting the nurses' ability to provide care to the patients. [Then in turn] that affects the ability to support those nurses ... it's easy to blame cost, but it's much more than that. (Darren)

Cindy mentioned the current contradiction in health care, *'Education seems to be the answer to everyone's problem that's out there but yet it's not really supported for staff to actually have education'*. She also commented on online education, a method of delivery that is growing in health care, *'It's definitely not as effective as face-to-face...'*. It became apparent though that this contradiction did not have to exist. Two of the nurses described learning to use NIV in facilities where education was provided. Lauren had nursed in a metropolitan hospital before gaining employment in her current facility. She explained that in her former employment:

We were more autonomous and we could adjust [settings on the NIV] within reason ... the training was more intense ... so it was more accepted in the culture that you were capable of ... titrating [the therapy] ... the baseline was quite high in comparison to this facility, I reckon ... I think you got a lot more experience and knowledge [in the metropolitan setting]. (Lauren)

Caitlin had joined her current facility after nursing in a hospital in Europe. She explained that she had learnt to use NIV in her orientation to intensive care when working overseas. The experiences of these two nurses show that it is possible for facilities to offer a supportive, educational environment when introducing new technology and the beneficial effect this has on staff such as Lauren who felt empowered and autonomous.

The nurses were also asked if they felt it was feasible for patients on NIV to be taken care of in the general ward setting. Their biggest concern was the ability of the facility to provide ward nurses with education to ensure they were able to care for patients on NIV. The nurses who were interviewed felt that if the current education offered in critical care was not enough to ensure safe practice, then the education that would be offered to nurses working on the wards would be similarly lacking.

When the nurses were asked what they thought about patients treated with NIV being located on the wards they had similar answers. Kat, from the ICU responded:

My concern would be adequate skill and adequate staffing ... No, I don't have a big issue as long as those two things were dealt with. (Kat)

Darren had similar reservations:

Yes, I think NIV is safe to be on the wards ... [but] there needs to be a whole culture change ... there needs to be policy and practice development ... appropriate government support ... ongoing education ... [and] a driving group. (Darren)

Darren felt that his current facility was at least five to eight years away from being able to provide these resources.

Lauren agreed that, 'Some serious education and training and support need to be given'. She also felt that enabling the wards to care for stable patients receiving NIV would assist to clear ICU beds. Lochlan also had some ideas:

I think theoretically, it's a really good idea. I think there's a lot of room for palliative [NIV] ... [and] it's probably relatively straight forward for [nurses on the wards] to set the machine up and change the tubing and do all of that sort of stuff properly. I'm more concerned they wouldn't recognise a deteriorating patient on [NIV] and I guess I'd be worried about that, a patient getting sicker and not really being identified. (Lochlan)

Caitlin answered:

I think it will be a good idea provided they get the training in the ward ... [it] would definitely reduce the number of admissions to [ICU] ... I think it [would] reduce the number of intubations as well. (Caitlin)

Education was therefore an overarching issue for the nurses when NIV was implemented. The low level of education they received had significant and wide-ranging effects. Many of the nurses directly named education as a common issue during the implementation of new technology. The effect of lack of education for the nurses resulted in them not wanting

technologies to be implemented at all. This extended to their beliefs about NIV on the wards as they did not want their nursing colleagues to experience what they had been through.

6.4.3 Isolation

The low level of education provided to the nurses before they commenced using NIV caused isolation of the nurses professionally and geographically. Professionally, this manifested as situations where there were limited NIV trained staff on duty and therefore the person using the NIV became professionally isolated. Lochlan explained that ICU patients could deteriorate quickly which sometimes meant that patients would have to be cared for by one nurse. The rest of the patients who had been allocated to that nurse at the beginning of the shift would have to be reallocated to other nurses. He went further and explained that the effect of the constantly changing acuity in the ICU often meant the nurses had to, *'Use someone [they] weren't expecting to, to look after the [NIV] patient ... that's happened a few times'*.

Darren described being alone in a large ED, looking after his first patient on NIV:

Was there enough preparation with me with applying [the NIV]? Probably not. Was there enough education ... or was there enough support from the senior staff member? No. Should I have looked at it a bit further? Probably. (Darren)

Isolation also occurred geographically as the smaller rural hospitals struggled with the equipment and were limited in regards to resources that could help. Jess discussed the limited number of nurses available to staff her rural ED and the significant percentage of those staff who were junior and had never seen NIV:

We had fairly recently a situation where ... the skill mix here [was] three RNs that were not registered as FLECC¹ and they called for help ... and the help was the [health service manager] at the time, who also had no clue what to do. So, yeah, that was interesting ... three to four RNs that had no clue on how to use this thing ... They didn't know how to turn it on, didn't know how to plug it in, no idea how to use it. (Jess)

Jess was asked to describe the type of support that staff in her unit could access when they were isolated in this type of situation. She replied, *'The only support we get with that is when we ring [the ICU] and that's it, other than that, we're on our own'*. When asked how she felt about the lack of support she replied she felt lonely.

¹ First-line emergency care course (FLECC) refers to a program rural emergency nurses can undertake to expand their scope of practice. Generally, FLECC trained nurses are senior emergency nurses.

Even when the rural staff had access to assistance either in the form of an on-call nurse or specialist assistance on the phone, the delays encountered were a reminder of their isolation.

Cindy related this to night shift:

You haven't got anyone to call on and even though [critical care specialists] say "Oh, yeah, I'm available 24/7" you're not going to ring them in the middle of the night.

She continued:

I know you can liaise with [large regional hospital] and you can use the Pexip² camera to talk to the critical [care] advisory team, but you've still got delays there in trying to actually get onto people. (Cindy)

The professional and geographical isolation felt by staff was present in both the large and small facilities. This is likely because of the lack of education for the nurses regardless of their hospital size. Educating only a few nurses led to isolated pockets of knowledge and therefore isolation of staff between those pockets.

6.4.4 Fear

The isolation and lack of education manifested in many of the nurses as fear of the equipment, fear of harming the patient and fear for themselves. When Emily was discussing the introduction of NIV into her facility she said the nurses, '*... were scared. We were really scared of it*'. She believed that fear was a significant barrier for the nurses being able to use NIV. Cindy, who was also from a rural site, talked about the reluctance of nurses to use a piece of equipment they had never seen before. She said, '*If you haven't used it, obviously, you don't tend to want to look after it*'. Jess was from a small rural ED where NIV was introduced without a training program. She talked about how she felt when the NIV machine was introduced:

It was awful, horrible. Yeah, we had no clue and of course there's this big machine that makes lots of noises and a lot of confused nurses that had no clue how to use this thing. So, no, it wasn't fun, it was quite daunting and quite scary. (Jess)

Working within a large regional facility with many resources did not protect the nurses from their fear of using NIV for the first time. Kat's first experience using NIV was on a large, busy HDU where several nurses were rostered on each shift and an educator was available. Despite this, when Kat was asked about her first experience using NIV, she stated, '*It was a bit terrifying*'. She went on to describe feeling, '*completely out of my depth. Completely out of my*

² Pexip cameras allow sites to link via videoconference so specialists can see patients from a different site.

depth'. This was similar to her second experience with NIV which she said, *'still sticks out in my mind as a really bad experience'*.

The nurses also discussed their fear of causing harm to the patient. Caitlin was an experienced RN when she moved to a new hospital and started to use NIV there on an unfamiliar machine with unfamiliar procedures. She discussed her fear of unsafe practice for her patient, *'You feel totally not confident to put the patient on [NIV] because you don't want to harm the patient'*. Tilly also described similar feelings about a situation in which untrained staff were looking after patients on NIV. She said:

I didn't feel very good about it. Like you think you're going in – a very unsafe practice, I didn't think it was safe practice, really, at all. (Tilly)

The theme of fear was not confined to the nurses' first instance of using NIV. Lochlan mentioned a new fear he acquired after a situation where one of his patients deteriorated. Up until that point Lochlan stated he felt very confident with NIV. He had been working in intensive care for several years and cared for many patients on NIV. He described a scenario in which he felt NIV was not an appropriate treatment for his patient and watched her deteriorate quickly until she required intubation. He said, *'My experience with her completely threw me ... Ever since, I've always had that in the back of my head'*.

The fear described by the nurses was most prominent when they first began to use NIV and were apprehensive due to their lack of training and subsequent isolation. It also occurred when adverse events happened such as that described by Lochlan. From the point in time when the nurses recognised their fear it became apparent they had a choice – to continue working in fear or to advocate for themselves and their patients, to find an avenue for emancipation.

6.4.5 Support and Mentorship

One of the first and most common ways for the nurses to overcome their isolation and fear was by finding support networks and mentors amongst themselves. Despite their fear and negative experiences, they did not give up striving to become competent with the therapy. The nurses commonly talked about their reliance on each other for education, support and mentorship. This was evident when the nurses were asked what had changed between their first experience of NIV in which they were fearful and undertrained and the time when they were interviewed when they felt comfortable to use the technology.

Darren, a dual ED and intensive care nurse, was adamant that support and mentorship from his peers were what had made him comfortable with using NIV. He said he had received, 'Excellent mentorship and support from nurses going above and beyond, not so much from just doing a daily job'. Darren was quite open about his positive feelings towards mentorship:

Obviously, there's that, that unofficial mentorship within the unit when, as I said, nurses have recognised that perhaps we actually support our own and appropriately teach support and develop other nurses ... I'm massive on, on mentorship. I think mentorship in its ... right frame of reference can really excel someone's ability to perform ... I think in the last 18 months there's been more growth and support towards mentoring and supporting people in nursing than what there has been in the previous eight years. (Darren)

He continued to explain what he would like to see emerge from nursing:

We need to work on nursing culture ... if you look at the old saying we know that "Nursing eats their own", perhaps if we could change that to "Supports and grows their own". (Darren)

Two of the other nurses also commented on how the support of other nurses had assisted them in their use of the treatment. Caitlin explained that when she started working in her current facility, she found that the NIV machine was different to what she was used to.

When asked how she overcame this issue Caitlin replied:

I got a senior person to explain [the NIV machine] to me, how it worked and how to switch it on and how to set the settings on it and how to fix the mask and everything. (Caitlin)

Kat had a similar experience when put in a situation in which she felt uncomfortable with the NIV machine:

I felt much happier, because there was another senior staff member who I had said to her "I'm going to call you ... and can you spend a bit of time [with me] when we get this patient?" (Kat)

Jess discussed how this support extended inter-facility. She talked about being isolated in her small hospital, but being able to rely on intensive care nurses in the neighbouring large facility for assistance and advice:

Like I said before, you're sort of left in the dark and it's quite a daunting thing, but [the ICU] is fantastic, so ... if we've got a problem we just ring and they know that we're stuck out on our own and we've got no help. (Jess)

Kat also spoke of her experience as a junior nurse being given one-on-one education by a senior nurse who was working as an after-hours clinical support:

That first initial educator ... actually went through slide presentations and talked me through a lot of it, gave me rationales and ... underlying things I needed to know. ... and I think, had I not had that initial hour of education ... I wouldn't have had the ability to really recognise what needed to happen. (Kat)

This shows the importance of intra-professional collaboration amongst nurses and the value of mentorship both psychologically and professionally. The nurses improved their practice by empowering and advocating for one another, and the positive influence this had on them encouraged them to want to do the same for others.

6.4.6 Taking Ownership

The support and mentorship the nurses offered to each other resulted in them taking ownership of their own education and ultimately of NIV as a treatment. As they recognised their need to teach and learn from one another, it became a self-appointed responsibility. The transformation was quite clear in several of the nurses who had begun using NIV when they were uneducated and scared. After relying on the support and mentorship of others to get them through the initial stages, several of the nurses put themselves through education and, recognising the need to give to their peers, began to teach other nurses what they had learnt.

Emily embodied this transition as she moved from asking for the NIV machine '*to be taken*' and being '*really scared of it*' to taking ownership of her education and attending courses. She signed up for a NIV course because she was, '*Just really scared of [NIV]*' so she thought, '*Well, I need to get into it and have a good look at this*'. She paid for the course herself and went in her own time. After that, she spent more time educating herself through reading and practising with the machine. Emily stated that she and Tilly started, '*... having a play ... and put together [our] own in-service for the other staff*'. Tilly and Emily now teach other nurses how to use NIV although, feeling like she is still no expert, Tilly said, '*Staff deserve to have better education*'.

Tilly had also spent time actively advocating for the education of other nurses in her facility. When the NIV machine arrived in her facility and was not used because the staff had not been trained, Tilly stated that she began, '*... that push of ringing and asking, and harassing people*' to visit her facility and give education. She said, '*That was how I started ... on the phone and ringing people like [the area clinical nurse consultant]*'. She also used the internet to search for

the company that provided the NIV machines and rang them to request a representative to visit her site to provide education.

The nurses discussed the importance that they teach and learn from one another as something that was accepted as part of their nursing practice. It was common for the nurses to initiate their own education or request for their education needs to be met. Regardless of their position or experience, the nurses took opportunities to teach and learn from each other. In this way, the individual nurses were both educators and learners according to the scenario in which they were using NIV. Cindy showed how, despite being a clinical nurse educator for six years, she became a learner in some situations with NIV and would rely on her co-workers to educate her. She commented, *'Even when you have a clinical nurse educator on hand they're not the expert at everything'*. Reflecting on her practice, she explained:

When there are nurses that are very comfortable in using [NIV] that makes you more comfortable to utilise it because you know that you are probably in that learning period ... [it is a] bit of a guide to have someone there empowering you. (Cindy)

Emily, Jess and Cindy, all from rural hospitals, elaborated on the requirement for nurses to teach each other after they had attended education sessions. This sometimes occurred when a company representative visited a site to introduce new equipment. In Emily's explanation of NIV implementation she said the company representative was present on-site for a couple of hours to give training to all of the staff. If staff were not present during that time for education, Emily said, *'Then it was up to [the nurses who were able to attend] to relay it'*. Cindy said the staff in her facility were also required to relay information to each other after education sessions. She used the example of educating staff on permanent night duty, *'We try to give them education by word of mouth ... on how to actually use [NIV]'*. Jess commented after her staff had attended an NIV education session, *'They'll talk about this now for the rest of the month and they'll tell everyone who wasn't here'*. She felt that this may also help to empower those who did not attend the education to come to the next one.

It seemed that the need for nurses to teach and learn from one another was not confined to the rural sites. Kat, from an ICU in a regional hospital, revealed that within health care:

... in general, is that expectation: see one, do one, teach one – you know, that whole idea. But I know that, formerly, we're moving away from that, but I think that's still very much the case: I'll show you, you do it. (Kat)

Despite the nurses having to learn in this ‘pass it forward’ fashion due to necessity, Jess demonstrated why this was a less than ideal method of education. She described some of the nurses attending a course and, on their return, attempting to educate the others:

They came back and showed us how to turn it on, pretty much. That was it, they weren't really 100% au fait with it ... So, it's like the blind leading the blind, I think. (Jess)

Another issue identified by the nurses was that despite their willingness to take ownership of their education, their ability to learn was still highly dependent on the availability of courses, cost and travel. Many of the nurses stated they were not supported or encouraged to attend education courses and therefore when they did it was on their days off and unpaid. Kat also commented on the effect of the general culture of the ward on nurses' ability to attend education courses:

I think, sometimes we don't feel as encouraged as we should, but I think that sometimes hampered by other things, like politics or other things on the ward that we feel frustrated by. (Kat)

Jess offered another explanation:

If it's not funded through the hospital [the nurses have] to pay for it themselves they won't do it, and that's an issue. My training over the last 12 months has cost me a fortune. I've paid for it myself – many won't and I don't blame them, that is an issue as well, we're only allowed two study days or learning days per year. (Jess)

Therefore, although the nurses clearly demonstrated their ability to take ownership of the practice of NIV, there remained barriers such as time constraints, financial considerations and ability to travel. The nurses had to navigate these barriers to continue to grow their practice and did so by giving up their own time and money to educate and support themselves and others. After taking ownership of NIV by educating themselves and supporting others to learn, the nurses became leaders of the practice.

6.4.7 Leadership

As the nurses grew in knowledge and practice, it was evident that they became leaders of NIV as a treatment. This was particularly common in the small rural sites where the doctors were not emergency specialists and commonly did not reside on-site. These factors made it particularly important that the nurses were able to lead NIV treatment. Emily described how nurses in her small facility could recognise the need for NIV and retrieve the machine and have it set up ready for use before a doctor was even on-site:

A couple of nurses here will get it out and get it set up because they can see – and I could probably ascertain that we’re probably going to go down that pathway ... I guess, I’m seen as a senior nurse, so ... if I think it should be used then we tend to go with that. (Emily)

Emily also elaborated on the effect of non-specialist doctors being employed in rural areas making it more essential that the nurses are able to lead emergency treatments such as NIV:

I am more than happy when there isn’t a doctor here. I mean, it’s good to have a doctor because hopefully they know more than you ... but, like I said, in this scenario with the NIV ... you’re often prompting them more than they’re prompting you, if you know what I mean. (Emily)

Jess, who also works as a RN in a rural ED, similarly discussed the requirement for nurses to lead NIV treatment. She described the ability of the nurses to collaborate with doctors to make treatment plans for patients on NIV:

With one of our patients, earlier, that had the adult respiratory problem [the nurses] initiated [NIV]... and [the doctor] said, “Okay let’s use it”. (Jess)

Jess went on to explain that using NIV usually came from, ‘... a group discussion ... but, yeah, nurses generally push for it’. She was then asked how the doctors reacted in these situations when they were guided by the nurses and answered:

Yeah, most of them are pretty good. I mean, they’re as familiar with the thing as what we are, so we just work together. So, no problem there. (Jess)

Darren and Kat, two of the experienced intensive care nurses from a large regional hospital also described how nurses within their facility took leadership roles in regards to NIV:

Those [nurses] who are quite familiar with respiratory nursing and [NIV] and the benefits itself will often suggest [NIV] to the medical team [and] can actually clearly define and give the reasons why [NIV] should be employed ... there’s nurses out there who are very, very, very clever and knowledgeable and ... know when NIV is an appropriate therapy. (Darren)

Kat explained a situation in which she and her nursing colleagues had taken the initiative:

I can remember a day when we had a patient who had been extubated and really wasn’t doing well and we had rung the doctors and said “You need to come and look at this patient ... we’re going to put on NIV” ... We stuck it on and went “Okay, well ... this is what we’ve done” which [the medical team] were very happy with. (Kat)

When discussing the reaction of the doctors to the autonomous practice of nurses, Kat explained many of the doctors would expect that the nurses could justify their clinical decisions:

There's the odd consultant who ... doesn't like that autonomous idea for ... whatever reason [but] mostly, if you can justify why you've made that decision ... and back it with clinical knowledge, then [the doctors do not] have a huge problem. (Kat)

Although most of the nurses found that taking leadership of NIV treatments had produced positive outcomes, there were also some issues with nurses taking on this role. There seemed to be a blur of professional boundaries at times due to the legal requirement for a medical doctor to order NIV clashing with the nurses' clinical knowledge of when NIV was appropriate. Darren summarised this issue:

Medical officers are responsible for [NIV] whilst nurses might be more than capable ... to make that decision, ultimately ... I don't think legally it's ... a nurse's responsibility [to make] those decisions ... Even though that medical officer might actually be a lot more junior in experience and practice base in NIV than that nurse. (Darren)

Cindy elaborated on the difficulty of blurred professional boundaries:

[NIV is] not nurse-initiated either so you can pre-empt that that would be the most appropriate piece of equipment but it's still up to the doctor on whether they want to use it or not ... he has influence, full stop. (Cindy)

At times this led to a discrepancy between the doctors and the nurses. Lochlan discussed that when he initially began using NIV he was, '*... really unclear about how much nurses were allowed to do without doctors being involved [which made him] quite nervous*. He later had a problem with a difference of opinion when he felt a patient was clinically too unstable for NIV, but the doctor:

... was very direct about what he wanted and ... I certainly explained that I thought she [the patient] might need to be intubated and he said he wouldn't think that – well, he didn't think that it was necessary. (Lochlan)

Lauren elaborated on the difficulty of starting NIV when working with some junior doctors:

Sometimes I find if you were initiating [NIV] on a weekend or an evening then it would be difficult given that you've probably only got a resident on and they might ... lack knowledge in initiating it ... and they might be hesitant. (Lauren)

Cindy, from one of the rural sites, discussed her discomfort at being put in situations where she was required to direct the doctor:

Very comfortable when you know that you've got a doctor that's familiar with the piece of equipment ... but when you've got a doctor that's ... not as familiar with it, I feel, like, there is a lot of responsibility on yourself to actually monitor the patient at higher levels ... [and be] the prompt for the doctor when he should be the prompt for me. (Cindy)

Despite the legal requirement for the doctors to order NIV, there remained situations when it was difficult for them to make decisions due to their own limited NIV education. They instead, had to rely a lot on the nurses and work as a team. In spite of the need to take a team approach, Tilly explained that it could still be difficult to actually work as a team:

Some [doctors] are a trifle more difficult than others to raise things with and they'll try to get you on the back foot ... some nurses battle with that ... [and] from the doctor's perspective, they sometimes think we're attacking them ... Another issue is that nurses learn so much about structure and A to Gs ... but sometimes the doctors start at F and it goes to chaos in a hand basket. (Tilly)

Tilly had a suggestion to improve teamwork by providing, '*... education [for] the medical staff and [for] the nursing staff, separately, possibly at first and then together*'. She felt that it was important to incorporate collaborative education because staff, '*... need to be on the same page*'. This was particularly due to the difficulty she had when some of the nurses had '*... gone off to [the regional hospital] and had some training, but the doctors hadn't had training*'. This resulted in the nurses having to educate the doctors. Tilly felt that this was inappropriate because, '*We felt like we were taking the responsibility ... and feeling that really shouldn't be our role*'. Another issue she had encountered was, '*... doctors not liking ... [and not] coming to education from nurses. They like to ... know there's a doctor there*'.

Leadership of NIV as a treatment was therefore defined by the scenario in which the clinicians found themselves. Despite the requirement for doctors to prescribe NIV, the participants described situations in which it was important for them to be the leader of the treatment and sometimes initiate it themselves. Many of the nurses were comfortable to do this but some felt that it was inappropriate – this responsibility was pushed onto them because the doctors were not given training.

6.4.8 Intuition

Once the nurses assumed ownership over their education and began to take leadership roles they continued to grow in their ability to use NIV to a point where, for some of them, their practice became intuitive. This was particularly evident in the nurses' description of how they assessed for patient deterioration or improvement during NIV treatment. Instead of relying on biometric values, most of the nurses described assessing their patients simply by looking at them.

Emily and Darren both gave similar answers when asked how they assessed their patients' status. Emily answered, '*We look at ... [the] patient's whole sort of body posture and things like that*'. Darren described how he assessed a patient:

I look at the patient across the room: Are they awake? Are they drowsy? ... Are they alert? ... What position are they sitting in? Generally, are they speaking in words, phrases, sentences, what's their breathing effort? ... It's a continual process of that assessment I guess ... it's an ongoing process. (Darren)

Darren explicitly stated that he trusted his instincts rather than biometric values:

It is my clinical picture, my clinical assessment that usually kicks off first because, quite often, I don't look at numbers in isolation ... Generally, I trust my clinical judgement first before I look at a number. (Darren)

The nurses identified work of breathing as the major indication of a patient's clinical status. This is a subjective measure of how difficult it is for someone to breathe, not a clinical parameter the nurses were objectively measuring. When Kat was asked how she determined if her patient was improving or deteriorating she answered:

So, first of all, looking at your patient, what's their work of breathing like, what's their colour, are they exhausted? (Kat)

Lochlan, an experienced intensive care nurse, also described how his experience had taught him to recognise patients who look well and have normal biometric values, but are actually deteriorating:

Patients can look comfortable but they're actually just decompensating ... they tend to look comfortable, again, but they're actually sick ... and that's a really subtle difference I think. (Lochlan)

Lauren also said she assessed her patient by looking at, '*Work of breathing, respirations, saturations, blood gases, whether the patient is ... becoming comfortable ... or more anxious and still struggling*'.

Cindy also focused on looking at the patient:

You would be looking at the patient themselves: where you think they are comfortable or they're distressed, their work of breathing, whether they're restless, anxiety, how they're actually sitting. (Cindy)

Tilly added: ... *work of breathing is the big one.*

The description the nurses gave of their intuitive practice is interesting for several reasons. Firstly, none of the nurses mentioned the word 'intuition'. This signifies that they view this type of practice as a norm. Secondly, the depth of the use of intuition as described by the nurses is also interesting because critical care is a highly medically dominated specialty that focuses treatment primarily on quantitative data. An example of this is that, although the nurses each described using work of breathing as their primary judgement for whether a patient is improving or deteriorating, at the time this research was undertaken work of breathing was not a measured parameter in any of the sites. The nurses have described an adjunct method of assessment – one that they have developed over years of practice, largely without their awareness.

The themes described by the nurses are the steps they took on the path to clinical intuition during their journey of using NIV. The introduction of new technology, lack of education, isolation, fear, support and mentorship, taking ownership, leadership and intuition are all stages interwoven with the overarching presence of power, as shown in Figure 6.3. They began in a place of disempowerment where they were not provided education, were isolated and fearful. This inspired their activism and they took ownership of their practice and emerged as leaders who could treat patients intuitively. The movement created a position of power for the nurses where they felt they could assess and treat their patients competently. Moving from a position of disempowerment to empowerment had consequences for both the nurses and their patients.

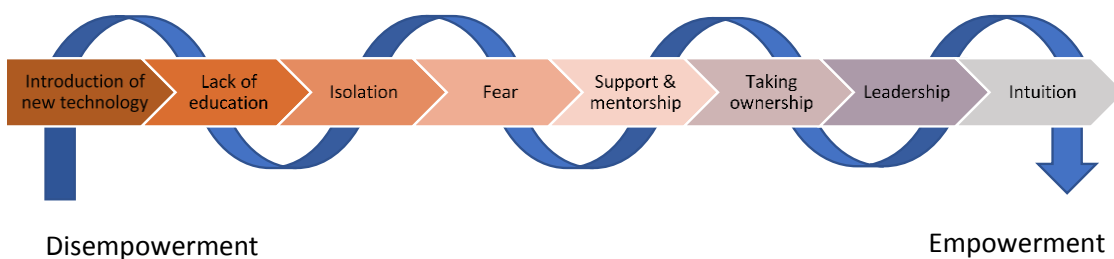


Figure 6.3 Movement of power on the path to clinical intuition

6.5 Influences on the Path to Clinical Intuition: The Whole Story

After the discussion of the stages presented in Figure 6.3 the interviews were revisited by the researcher for a deeper analysis. There remained a need to discover what, if anything, influenced the nurses to move across the stages. It was important to identify if there were any nurses who had remained stagnant at one point or had even moved backwards. The interviews were further analysed to determine if any of the nurses had provided insight into this new query. Many of the nurses spoke of their belief that they were personally responsible for their growth as an adult and as a nurse. Kat stated:

We're adults and we need to do self-learning, so I think it's important to remember that as well, that it's not all handed on a platter, that we should have an expectation that we review things ourselves ongoingly [sic] ... I think that part of our obligation as nurses is to self-initiate [education]. (Kat)

Caitlin also spoke of initiating her own education:

I take it as my personal responsibility to keep up with the new changes ... I don't expect the facility to give me chances, I try my level best to keep up. (Caitlin)

When asked about his thoughts on nurses self-initiating education, Darren answered:

I think in today's world it's a must. I think the moment that you stop learning and stop growing is the moment that you need to give it up ... We need to embrace the technology, we need to embrace the development of policy ... because the moment you stand still I think that's when it's all over. (Darren)

Darren further elaborated on this:

Personally, I think everyone should [self-initiate education]. Whilst I don't think that everyone should go out and do a [Graduate Certificate] every year, I still think people should be making an effort to further their knowledge in practice development. (Darren)

Another explanation for movement between the stages was offered by Cindy and Lauren. They explained that many nurses participate in education and training for themselves so that they do not have to feel afraid of using treatments they are unfamiliar with. As Cindy noted:

Most of the night duty girls are happy at the end of their shift to do a little bit of training if they know that that alleviates their fear with pieces of equipment that they've not used before. (Cindy)

Lauren said:

I realise that the organisation can't fund everyone to do ongoing education ... I chose to take myself back and remember the basics and

to see was there anything that I was missing and by completing the [course] it gave me more confidence to know, actually, I do know what I'm doing. (Lauren)

Tilly felt that: *On all sites a lot of the nurses will come in on their days off³.*

The nurses were also asked what they saw as making the difference between when they initially started using NIV and when they felt competent treating the patients with it. Exposure to using NIV was identified by some of the nurses as the reason they were able to move to being competent with the therapy. Kat agreed that exposure had an influence on her becoming comfortable with using the treatment. She also added:

Part of it has been learning more along the way ... reading up on [NIV] guidelines and learning about ventilated patients ... that combination [of exposure and education]. (Kat)

Caitlin similarly believed it was the number of patients she had looked after on NIV machines that had given her the confidence she currently has in her practice.

The other factor identified by the nurses as influencing the fluidity of their practice was education. As Cindy commented:

I would love ... someone in the area with every piece of equipment that comes out, someone that comes around every couple of months and does an expert in-service ... I just think ongoing education with pieces of equipment is needed. (Cindy)

These thoughts resonated with Darren who stated what had helped him transition from isolation and fear to leadership and intuition was, '*... my education, my knowledge, excellent mentorship and support from nurses going above and beyond*'. Exposure to NIV and education were therefore identified as important factors for the growth of staff.

Another subtle reason for the nurses becoming more intuitive with their practice was for their patients. Many of the nurses discussed their ongoing commitment to giving their patients the best care possible. Kat believed this was so important that it was worth her being reprimanded.

As she explained:

If all things went to hell in a hand basket, I would change [the settings on the NV machine] ... and live with the consequences if the patient needed that. (Kat)

³ 'days off' refers to time when the nurses are not being paid.

Kat also felt it was reasonable to question a co-worker, such as a doctor, if she felt their decisions were not in the patient's best interest:

I think it's our obligation ... and I have often said "Can you tell me why you're thinking this, rather than that ... I just want to understand where you're coming from". (Kat)

She also explained that this could be more of an issue when junior doctors were on duty:

Often with junior [doctors], they can feel like you're trying to gazump them or something, but with consultants, they never seem to have a big issue when you're asking questions. (Kat)

But her overall feeling about the issue was, *'I feel very confident that I could advocate for my patient if I believed [that's what they needed].*

Darren spoke similarly about his patients and said when treating patients, *'[nurses should] always make sure you're doing ... the most good, you're not doing harm'*. He also related nurse education to patient outcomes:

We need to ... keep educating ourselves ... because otherwise what's going to happen is technology is going to surpass us and that's not good for patient outcomes. (Darren)

His feelings towards NIV were, *'If [the] patient needs NIV ... then the patient gets NIV [and everything else] comes second'*.

The articulated reasons for movement between the stages are therefore feelings of personal responsibility, desire to alleviate fear and a need to decrease the risk of harm to the patient. Identified strategies for the nurses to move through the stages were through education and practical exposure.

Some reasons for nurses not progressing through the stages also emerged. The nurses interviewed who worked as educators spoke of their experiences in this role. As a nurse educator, Lauren has had experiences where nurses were not willing to participate in education. She explained:

You can lead a horse to water but you can't make it drink and that is definitely the case with adult education ... if they're not self-motivated enough to want to participate in ongoing education then it's very hard to get that message across to them. (Lauren)

When asked about the reasons why nurses may not want to receive ongoing education Lauren answered:

They can be very dismissive and say “Oh, I know this already” but in clinical practice you see that they don’t ... they’re over self-confident.
(Lauren)

Jess also described the effects of finance, travel and family on nurses’ inability to attend education courses and hence their stagnation on the path to clinical intuition.

The nurses reflected on negative experiences that they had had with patients on NIV and how this had affected their practice. Lochlan reflected on a negative experience in which a patient deteriorated quickly:

I felt really comfortable with being able to talk patients into ... adjusting to it and getting used to it, and my experience with her completely threw me ... ever since, I’ve always had that in the back of my head ... I’m certainly not as confident as I used to be with putting it on people and just assuming it’ll be fine. (Lochlan)

This shows that at any stage of progression there was the possibility of both backwards and forwards movement. Lochlan was a senior ICU nurse who worked intuitively when treating patients using NIV until he had a negative experience that resulted in him moving backwards through the stages to a place of fear. This reflects the importance of situational effects on the ability of nurses to perform clinical tasks. A nurse may be considered an intuitive clinical leader in one scenario and in a different context become isolated and fearful. Figure 6.4 shows that although most of the nurses moved proximally on the path to clinical intuition, there remained a possibility they could fall backwards. This is symbolised by the arrow pointing distally. The nurses can move backwards to any previous point on the path at any one time.

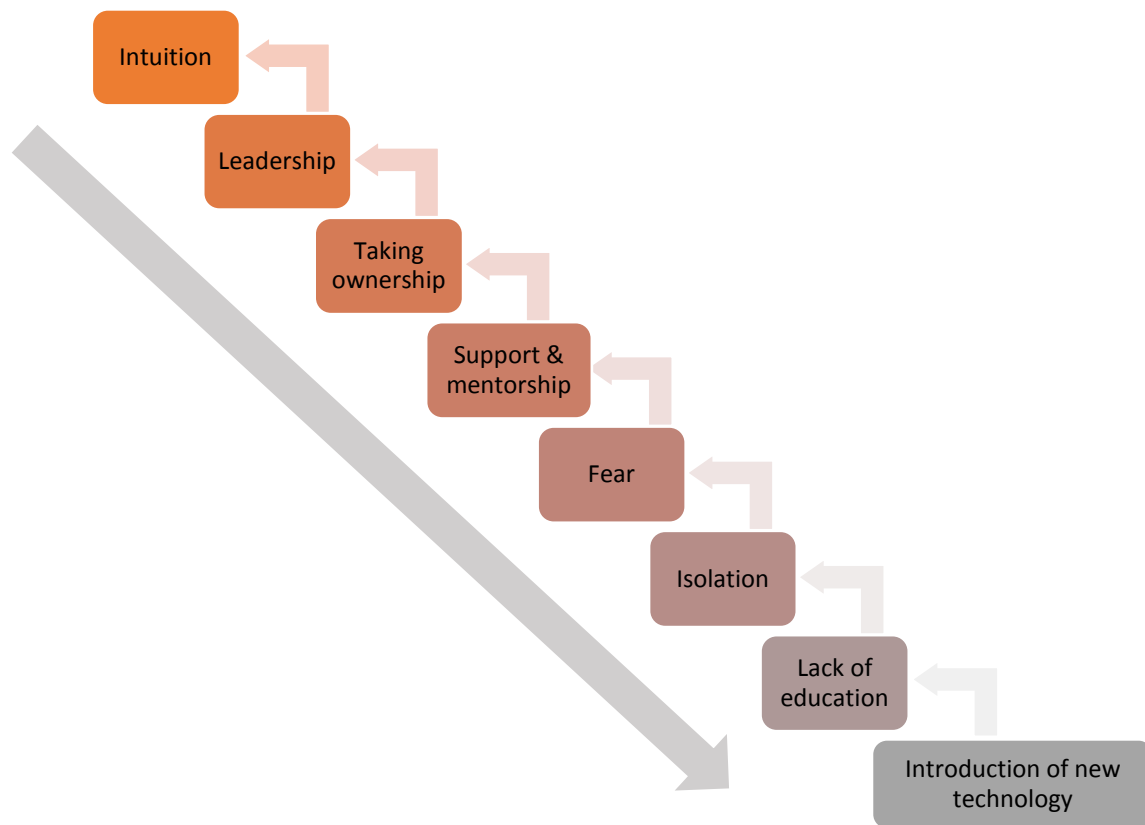


Figure 6.4 The path to clinical intuition

6.6 Reflection

As a critical care nurse myself, the interviews with these nurses were particularly emotive for me. I have spent many years working in this industry, even working with some of the participants and understand the context from which they have spoken. The themes presented in these interviews are also my truth. The issues of power, education and isolation have been commonalities for me in every hospital in which I have worked. This may be why, after listening to the participants, I had a desire to tell their stories. Not only did these interviews make me feel empathy and sorrow for the neoliberal structure that has become health care, but they also made me feel hope. I was nearly brought to tears by the words of some of the nurses. They have been servants to the cause of the system and yet they have not lost their humanity and desire to care for others. The stories of growth from fear and oppression to leadership and power symbolise the type of person it takes to be a nurse. I am not referring to the type of person who is employed in the occupation of nursing. The nursing I refer to goes beyond the art and science of the profession. It is the full embodiment of what it means to care for another human, something I have found inspiring.

It is also interesting to note that the nurses who volunteered to participate in these interviews all showed an ability to move forward in their practice. This may represent the type of people the participants are. Those who are willing to embrace change and expose themselves to new things in nursing were similarly open to being interviewed about their experiences. As I examined the reasons why many of the nurses moved through the stages to clinical intuition, I reflected on my own movement throughout my career and the reasons behind my own change. I have continued to study and research for several reasons, one of course being curiosity. Other reasons resonate with what the participants described. I do not want to work in a situation where I am afraid of the technology I am using to treat critically unwell people. I move forward for myself, to challenge myself and alleviate those fears for my patients – to ensure I provide them with the best care I can achieve, and for my colleagues – so that I can educate and support them so that they too can receive these benefits.

6.7 Chapter Summary

This chapter has examined the results of the semi-structured interviews that were conducted in the qualitative phase of this research project. These questions were formed from the results of the quantitative phase of the project with the view to provide context and depth to the empirical data. There were eight major themes identified from the data including introduction of new technology, lack of education, isolation, fear, support and mentorship, taking ownership, leadership and intuition. Many of the nurses moved sequentially across these themes but they also identified the possibility of moving backwards or remaining stagnant. The nurses' interaction with NIV and their ability to use it were highly related to the context of each individual episode of use. The next chapter will integrate the results presented in Chapters 5 and 6 to show the specific overlaps of the data and where the qualitative data were able to enrich the quantitative findings.

Chapter 7: Mixed Results

7.1 Introduction

The previous chapters have examined the quantitative and qualitative results of this project as individual entities. This was important so that the results of each of the methods could be explored in detail. This chapter examines the results of the two phases of the project together. The purpose of conducting the qualitative phase was to explore elements of the quantitative results that could not be explained using the statistical data. This chapter will demonstrate how the results of the phases are moulded together to fill the gaps of inquiry and give a broad overview of the use of NIV in clinical practice. The integration of the quantitative and qualitative results will be presented as topics of interest raised by the quantitative data, followed by the explanatory discourse offered by the qualitative inquiry. This fits within the sequential explanatory design used in this project as the quantitative data were the primary focus and will lead the results discussed in this chapter.

7.2 Factors that Affected the Use of NIV and Prescription of Standard Medical Therapy

The first quantitative finding to be investigated using the qualitative data was related to the number of patients who received NIV compared to those who were eligible to receive NIV. The quantitative results showed that of the 71 patients who were eligible for NIV, 45 (63%) were administered this treatment. Considering all of these patients met the criteria for NIV treatment and presented to a hospital with the equipment needed for this treatment, the discrepancy between the number who should have been treated with NIV and the number who were treated with NIV required exploration. In addition to the variation in whether patients received NIV or not, the quantitative results found that the group who were given NIV also received different standard medical therapy compared to those who were not treated with NIV. The standard medical therapy administered to the patients is outlined in Chapter 5. Most notably, the group who received NIV also received more corticosteroids and more antibiotics than the group who were not administered NIV. The NIV group were also given a wider variety of medicinal treatment compared to the group who did not receive NIV. Although this difference did not reach statistical significance, it is important to examine possible reasons why these two groups were treated differently. There were several possible explanations for differences in patient treatments across individuals and facilities. The qualitative data revealed

factors such as clinician adherence to clinical guidelines, time of day, skill mix, responsibility of NIV initiation, and interdisciplinary collaboration-affected treatment decisions.

7.2.1 Clinician Adherence to Clinical Guidelines

The first point of exploration was to determine if clinicians were using the NIV guidelines. The nurses were asked if, in their clinical practice, the available guidelines were consulted when making treatment decisions. There were several inconsistencies in the answers given by the nurses. Some were not aware that the guidelines existed. When Jess, from one of the small facilities, was asked about the use of guidelines in her hospital, she stated she was not aware there were guidelines, *'No guidelines until now. Yeah, we just go off what we're told'*. She was then asked if, now she was aware of the guidelines, would she use them in practice and replied, *'Yeah, bloody oath, yeah. Well, I'll download that first thing tomorrow'*.

Darren's answer differed in that he stated he was aware of the guidelines but implied the use of them was so rare they might as well not have existed:

My first reaction to that, which is rather negative ... was "What guidelines?" ... I don't think they get used at all to be honest, it's very, it's a bit like ventilation plans, it's like how many patients actually get ventilation plans put in place? ... it doesn't happen. Should it? Yes. (Darren)

He was then asked why the guidelines were not used:

...times when I would be using it, generally there's also other senior nursing staff around to help problem solve and diagnose who are very current and ... evidenced based as well, which also is obviously a benefit. I guess even though this is a bad answer, I guess I tend to go looking for the policies and procedures when I don't know the answer or if I'm less confident in what I'm doing. (Darren)

This answer showed that staff may be more likely to consult guidelines when they feel they need the guidance and do not have the support around them to help with treatment.

Kat, who was from the same large facility as Darren, expressed similar sentiments:

I think, though, interestingly, the people who haven't used it as much go far more by the guidelines ... I think we sometimes get complacent when we feel competent and therefore we don't feel like – we feel like we've got a better grasp on it than, perhaps the guidelines, but the fact that the guidelines are there to guide us, I think is something that's important to not forget. (Kat)

Lochlan discussed his opinion of the use of guidelines by the doctors in his facility:

I can't see any evidence of them using a guideline or something to work it out, it seems to be very instinctive or intuitive the way they do it. It just seems to be based on what they know rather than best practice guidelines. (Lochlan)

Although, he stated that he used the guidelines for his own practice:

So, I guess that's my bible recently [the state guidelines]. And then our local, or district procedures, have been based marginally off that document, so I'm confident that ... our policies are consistent with best practice. (Lochlan)

Comparing the answers of the nurses from the large regional facility to those working rurally, the most notable difference was the reliance of the rural nurses on the guidelines. Emily felt that:

Now that we've got the policy that you've got together, that's really good, because it gives us some guidelines because we were just sort of flying blind. (Emily)

Tilly, from the same rural facility, was asked what she thought clinicians in her hospital used to make treatment decisions. She answered:

I think they're using that procedure ... we've got a folder sitting on the trolley and that comes out. So, they go through in the folders, the procedure, and ... quick set-up guidelines. (Tilly)

The answers given by the nurses in the interviews showed they were not all aware that guidelines were available to assist them to use NIV. There were even some nurses who recognised that guidelines existed but did not use them. According to the nurses, this was also true of their medical colleagues who did not always consult treatment guidelines when using NIV. The variability in use of guidelines across facilities, professions and individuals could be the reason not all patients who were eligible for NIV received the treatment. It should be noted that the nurses from the rural facilities stated they were more likely to use clinical guidelines compared to the nurses from the regional facility. This then, does not corroborate the quantitative finding that patients were less likely to receive NIV if they presented to a rural facility. Alternative effects on clinical practice were therefore also investigated.

7.2.2 The Effect of Available Skill Mix and Time of Day on Clinical Treatment

After exploration of the effects of guideline use on NIV treatment, some of the wider issues were explored. A broad approach was undertaken to determine if there were any other underlying issues affecting the use of NIV in practice. The nurses were each asked what they thought affected their ability to use NIV in practice. Their answers related to issues with skill

mix (i.e. there were nurses rostered on the shift who were not trained in the use of NIV) and time of day.

The nurses from the large regional facility recognised fewer barriers to administering NIV compared to the nurses from the rural hospitals. When asked if there were factors that affected their ability to treat a patient with NIV, their replies were similar. Lauren stated, *'I don't see too many barriers for [NIV]'*. Caitlin was asked about barriers she encountered and answered, *'No I've never noticed, it's primarily how your patient is doing'*. Kat felt the same, *'In my environment, I don't think so. I feel very confident that I could advocate for my patient if I believed'*. Darren described the treatment as patient-dependent, *'No, as far as I'm concerned ... if a patient needs NIV they need NIV'*. Lochlan replied, *'I'd like to think that certainly between nursing staff there's a fairly consistent approach'*.

Despite the nurses from the regional facility describing few barriers to their use of NIV, they did discuss issues with skill mix. In contrast to the rural facilities where there was a lack of staff trained to use NIV, the nurses in the larger regional facility stated their skill mix issues were mostly due to the senior nurses being required to care for patients on invasive mechanical ventilation, leaving the junior nurses to look after patients on NIV. Lochlan described scenarios in which this occurred:

I've seen situations where nurses with very little training on it have been asked to watch a patient, based on the other patients, the acuity on the ward, meaning that we sort of need to give – either a ward nurse or a postgrad or someone with little experience in BiPAP all of a sudden having to watch it, and they get chucked in the deep end in a way that doesn't really happen with other things. And that concerns me a bit. (Lochlan)

Kat's first experience using NIV as a new graduate nurse, two months into her program, has previously been described and corroborates this example given by Lochlan. In addition to requiring junior nursing staff to care for patients on NIV, the nurses from the regional hospital discussed the requirement for junior doctors to oversee NIV treatment overnight. Lauren's description of this issue has previously been discussed. She felt that initiating NIV overnight or on a weekend could be difficult due to the absence of senior doctors in the ICU. She thought that relying on junior doctors to prescribe NIV was difficult because they had little training and exposure to the treatment. Lochlan and Kat felt that the coverage of ICU overnight by junior doctors reiterated the importance of clarifying treatment goals in hours with the intensivist. Lochlan stated:

I'm aware that if we don't clarify the goals in hours, that out of hours is still going to happen whether it's my patient or not. And so, it's very important to have the doctor set parameters that they're happy with, that are patient specific, and the nurse has clear direction on what they're supposed to do. (Lochlan)

When asked about the effect of night duty on use of NIV, Kat had similar sentiments:

I guess the only thing I would think of using at night is, if this patient deteriorates; what's our plan? (Kat)

Cindy, from one of the small rural sites, felt that her ability to use NIV was affected by the doctor rostered on, the time of day the patient presented and the training of the nursing staff rostered on. Emily, also from a rural facility, agreed that the time of day and the number of staff available affected her practice:

I'd feel way less comfortable on night duty using it than in the morning because there seems to be – there's loads of staff around. On night duty, there's only three. (Emily)

Jess gave an example of how inappropriate skill mix had previously impacted on the use of NIV in her facility:

We had – fairly recently – a situation where our skill mix was horrendous ... three to four RNs that had no clue on how to use this thing [NIV]. (Jess)

She did, however, have a different opinion of the effect of time of day on patient care in her facility:

I'm actually more comfortable to use it on night duty because the doctor will be here, and generally if we've got a patient that's requiring BiPAP and we're on night duty, then of course we're waiting on transfer out. So, no, night duty is probably better because it's not as busy. Other patients are asleep. We can solely concentrate on this one person. (Jess)

The nurses from both the regional and rural facilities recognised that the context of their practice, particularly regarding skill mix and time of day, had an effect on their use of NIV which was different according to each facility. For example, the nurses from the regional hospital felt a lack of senior staff affected their practice whereas the nurses from the rural facilities felt that a lack of staff numbers affected their practice. Most of the nurses identified that working overnight affected the prescription and use of NIV; only Jess felt that this effect was positive.

7.2.3 The Introduction of New Technology and Education Offered to Staff

After the discussion with the nurses regarding their personal views of the factors that may inhibit their use of NIV, factors that may have indirectly affected their use of NIV were examined. The participants were asked about the way they were introduced to NIV, the education they had received and if they were given ongoing support to build their skills in this area. The experiences the nurses had when they were introduced to NIV and in subsequent years may have influenced their feelings towards the treatment and thus the likelihood they would use it.

The way the nurses were introduced to NIV was quite standard across all the hospitals. As Emily explained, *'The NIV machine just arrived. It literally – I went down one morning and it was there in the ED'*. This was very similar to Lauren's introduction to the NIV machine, *'We got the v60 and it was a matter of, you know the basics, figure it out on this'*. Tilly even described how, due to none of the staff being trained on how to use the machine:

It actually sat there for a while, because there was no education with it, other than a quick in-service when it was actually popped in by [the company] and that was it. (Tilly)

Cindy added that, in addition to receiving no education when the NIV machine arrived at her facility, they also had no documentation forms to use in their practice:

I would say that I didn't think that the roll out was received with enough education at the time and, in particular, the forms that are specific to using a v60 noninvasive compared to invasive ventilation forms still hadn't arrived. (Cindy)

It is evident that the way NIV was introduced to the nurses affected their clinical use of the machine directly, because they could not use a machine they had not been trained to use. It also affected them indirectly, through the creation of fear and distrust of a piece of equipment they did not understand but were told they must use. This explains an initial hesitation to use the NIV machines and would have impacted the number of patients who received NIV treatment, causing some of the discrepancies found in the quantitative results. Following the introduction of the NIV machine, the nurses were asked about their experience of education and ongoing support to facilitate their use of NIV.

There was significant variability in the training and education the nurses had received in regards to NIV. Lochlan described having unstructured training whereas Lauren and Jess stated they

were not provided with ongoing training at all. When asked if he received ongoing NIV training, Darren replied:

No. So generally in our, I guess with our facility with its current workload demands with having a fluctuating workforce and not a steady workforce, I think 95% of the education gets tailored towards the newer, new nurses, emerging nurses, development nurses, junior level RNs and ENs etc. And it gets tailored towards that I guess from a risk management point of view. (Darren)

Kat thought there had been some NIV education in her facility, but agreed a lot of education was tailored to junior staff, *'The junior staff have received a lot more from the educators than perhaps middle to senior staff, over time'*.

The nurses felt that ongoing education was equally as important as the initial introduction to NIV. On the topic of education, Tilly stated:

Education just can't be a one-off and then stop and never be heard from again ... I mean, I suppose [NIV] is like any skill, like we reassess a FLECC accreditation every year and I think, at least an annual update and review, and practise and stuff in NIV, because it's so spasmodic, but it's so important. (Tilly)

Jess was frustrated about the lack of initial and ongoing support for education and the reliance on nurses to teach one another:

I think they just assume that we've got it, we should know and there's an educator there. The educator will teach them and we haven't had an educator here for quite a long time, so there were gaps there. But yeah, I think they just assume once one or two people get the training then everybody will be trained from those two people. Not always the case. (Jess)

The use of technology for educational purposes was also discussed with the nurses. The nurses felt that perhaps simulation technologies were useful, as Lauren pointed out,

'Oh yeah, simulation would be good. We got better and better simulation technologies, so by all means'. But she also mentioned there was difficulty in simulating a patient in acute respiratory failure which influenced the efficacy of the training. Tilly said when she was learning to use NIV, *'I used Google and there were a lot of good YouTubes'*. Others had experienced difficulty using technology for educational purposes in the past. Cindy did not feel that online education was as effective as face-to-face due to delays in downloading and the inability for interaction. Tilly had been sent online training material for the set-up and use of NIV but found:

The webinar really didn't work for staff, it just wouldn't download on our computers, so that was a real problem. So, I did a couple of in-services with it, but I could only do a section at a time, because it was taking nearly half an hour for each section to download. (Tilly)

The qualitative data showed that the way the nurses were introduced to NIV and the ongoing education they received had an effect on their use of the treatment. The initial lack of education resulted in NIV not being used for a period in the rural facilities. The nurses also felt that education on the use of NIV should not be provided only once, but should be ongoing at regular intervals. While technology was useful for some of the nurses' education, other nurses felt that it caused delays and was less effective than face-to-face training.

7.2.4 The Initiation of NIV

Another factor considered in the exploration of the use of NIV was who was responsible in each facility for the initiation of NIV. Variation in the initiation of NIV may have affected the likelihood patients would receive the treatment. To explore the effects of variable medical and nursing staff on treatments, the participants were asked about their experiences of who was responsible for making the decision to use NIV. Cindy felt that the initiation of NIV was solely the responsibility of the doctors. Kat described how, although this was technically true, in practice, she had previously made the decision to use NIV before consulting with the doctor, because of her patient's serious condition. Darren and Emily also pointed out that several nurses would suggest to the medical team that NIV should be implemented, particularly when they were working with doctors who were unfamiliar with the treatment.

The nurses felt it was important they were respectful to their medical colleagues when initiating NIV themselves. Emily felt it was important that she informed her medical colleague before she commenced NIV:

I probably wouldn't just go and grab it and start it without at least notifying a doctor. I'm happy to say, "Look, I think he needs BiPAP, can I start it while you're on your way?", but I wouldn't just start it up and tell him an hour later that I've just put someone on BiPAP. (Emily)

The nurses felt there were two main reasons why they had to advocate for the use of NIV. The first reason was due to the rotation of the doctors and subsequent variability in their knowledge and application of NIV. As described by Darren:

I guess it makes it hard when different consultants in the same specialty and even sub-specialty disagree on the use of NIV. (Darren)

It is possible that the inexperience of the doctors with patients in acute respiratory distress may also have influenced the variation in standard medical therapy prescribed, as was found in the quantitative results. This was described by Lauren as occurring when junior doctors were present in the large regional facility and by Emily in regards to the ED being staffed by general practitioners. Emily stated:

I feel the doctors, they don't have a good grasp of it and they don't use it all the time and some have come to the training, some haven't come to the training. (Emily)

It appeared from the answers given by the participants that there were differences across facilities and professionals in regards to their thoughts on who was responsible for the initiation of NIV. Although technically a decision by a medical officer is required, in practice, NIV initiation varies from being nurse-led, to a collaboration, to being purely medically led. This difference is a result of the individuals and often the training they have received. The scenarios in which the nurses felt they had to lead the treatment were those in which they were the ones who had received training when the doctors had not. The variations in the initiation of NIV relate to the quantitative finding of discrepancies in medical treatment received by the patients. If doctors do not receive standardised training in regards to treatment options it is inevitable that treatments prescribed will be variable. Throughout the discussion with the nurses regarding the initiation of NIV, it was evident that the levels of collaboration between the medical and nursing staff affected treatment decisions. The effect of collaboration on treatment decisions was examined further to explore this phenomenon.

7.2.5 Interdisciplinary Collaboration

The nurses described the requirement for them to collaborate with and sometimes lead doctors in medical decisions. This introduced the issue of whether the professional relationship between the doctors and nurses affected the use of NIV. As the nurses described scenarios in which they had been required to question a doctor, they were asked how they felt in that circumstance and how the doctor being questioned responded. Some of the nurses in the smaller rural sites felt they had a healthy professional relationship with the doctors because they recognised they needed one another. Jess explained that in her rural facility most of the doctors were happy to work collaboratively because, like the nurses, they were offered little education on the use of NIV. Emily had the same thoughts:

It's sort of a team thing. A couple of the doctors – you'll be talking with them, saying, "Well, shall we do this? Should we do that?" ... and so,

you sort of all work together because I think it's still, not the unknown, but we're still all in early days. (Emily)

Emily went on to explain the importance of building a rapport with doctors so that the working relationship was maintained, *'I think once they get a rapport with you and you say, "You've got to come now", they'll come'*.

Tilly felt that this working relationship was also dependent on the training of the nurse:

Yeah, look, generally, I mean rural doctors do rely a lot on – and it has to be a team. But then that goes on the nurse's experience and I guess ... and the nurse's knowledge, and then the nurse's competence. (Tilly)

When asked if they felt comfortable to question doctors' decisions, the nurses had various answers. Lauren answered:

I think that there's a certain population who culturally might not be as assertive as sort of others and they might take on 'what the doctor says' type approach ... also we are, we have got a very junior workforce at the moment who are a bit inexperienced and they don't have, obviously haven't had, the exposure or the experience to confidently say, "Oh, we can apply this at these settings and we should achieve this outcome". (Lauren)

Jess felt that it was an individual situation, *'I think, generally, they are [happy to question doctors]. It depends on the doctor'*. Kat agreed that it depended on the individual doctor and whether they were comfortable to be questioned. She emphasised the importance of the nurses being courteous when they raised questions or disagreed with treatment decisions. It should also be noted that, in situations where collaboration was not achieved, there were sometimes negative outcomes for the patient. This is evidenced by the story told by Lochlan who had raised concerns with the doctor that were ignored, resulting in the patient deteriorating.

Interdisciplinary collaboration is evidently important for treatment decisions during the use of NIV. The nurses have demonstrated how their working relationship with the doctors affected treatment decisions. The various levels of collaboration among individuals and across facilities contributed to the variability in treatments.

The qualitative data have identified six possible reasons to explain why only 63% of eligible patients received NIV and these were: adherence to clinical guidelines, skill mix, time of day, the way nurses were introduced to and educated on the use of NIV, the ability of nurses to initiate NIV, and the effect of local interdisciplinary collaboration. The nurses generally felt that clinical guidelines were not always used, treatment with NIV was more difficult overnight

and when skill mix was poor, and the education of staff at the time of introduction of NIV and in subsequent years was lacking. They also felt that interdisciplinary collaboration was important for initiation and ongoing use of NIV, but it did not always occur. These factors may all have contributed to the difference in the number of patients who received NIV compared to the number of patients who met the criteria for treatment with NIV but did not receive it.

7.3 Treatment Varied According to Hospital Size

The quantitative data revealed that patients who presented to a large regional hospital had an 80% chance of receiving NIV for their severe asthma. This was significantly different compared to the likelihood of receiving NIV when presenting to a medium or small rural hospital (43% and 42% respectively). The effect of the exposure of nurses to treatment of acute asthma presented as a possible reason for this difference. The quantitative results found differences in the number of patients presenting to each hospital with severe asthma each year. There was only one hospital (Hospital A) that recorded severe asthma presentations every year for each of the years included in this project. Although the qualitative data could not account for the variation in number of admissions to sites in each year, there were other issues that may have arisen from the variation in exposure of the staff to treatment of severe asthma with NIV. The nurses were asked about their exposure to severe asthma and use of NIV to determine if this may have contributed to differences across treatment in individual facilities.

7.3.1 The Effect of Exposure to Severe Asthma and NIV on the Nurses' Clinical Practice

The nurses were asked what diagnoses NIV was commonly used to treat, to determine if they had experience using it for patients with acute exacerbations of asthma. Considering the quantitative data reflected relatively low rates of severe asthma admissions in some sites, it was possible the nurses may not have immediately considered it as an indication for using NIV. Conversely, the nurses being interviewed were aware the researcher was conducting a study on NIV for the treatment of acute asthma and this may have been in the forefront of their minds. When discussing the types of diagnoses they treated with NIV, some of the nurses did not mention asthma. Cindy answered, '*Usually, our COPDs and pulmonary oedema*'. Lauren agreed:

A lot of COPDs ... I've seen it on cystic fibrosis patients who've got an infective exacerbation, I've seen it used in patients that are pulmonary fibrosis ... Pneumonia. (Lauren)

Other nurses did mention asthma. Tilly identified, 'APO [acute pulmonary oedema] ... *some COPDs and it's probably sorting out, like, asthmas from different things*'. Jess stated, 'Oh, a lot of COPD, we've got a lady here with bronchiectasis that we use it on, asthma of course, and the influenza A'.

Some of the nurses working in the regional site mentioned a wide range of indications for which they used NIV, including asthma. Lochlan identified:

Exacerbation of COPD is probably the most common one. We use it in APO a lot, particularly with CCF [congestive cardiac failure]. We use it for pneumonia on some patients, particularly when intubation isn't desirable ...we use it for asthma sometimes. (Lochlan)

Darren's answer was even more comprehensive:

Pneumonia, pertussis, influenza, COPD ... obstructive sleep apnoea. What else? Any, anyone that comes in drug overdoses who are, who basically haven't got, who are hypercapnic or hypoxemic ... but are still awake and alert and still able to have that respiratory drive and effort, just needs support ... sometimes you get a bit of postop atelectasis ... asthma I guess you do see, also I guess, traditionally, over recent times we've seen more CPAP involved or high flow nasal prongs with asthma opposed to actual BiPAP so to speak. (Darren)

The qualitative data presented above demonstrated that the nurses from different sites had varying opinions in regards to which pathophysiologies were treated with NIV in their sites with some of the nurses not mentioning asthma. This aligned with the quantitative differences in asthma presentations across facilities as the nurses working in sites with fewer asthma presentations would be less likely to associate NIV with asthma. In addition to differing levels of exposure to acute asthma, the nurses were also asked about their exposure to NIV as a treatment.

When asked how many times per year they used NIV as a clinical treatment, it was evident the nurses working in the regional facility had a lot of exposure to NIV. Lauren stated, 'We do see quite a lot', which was similar to the answers given by Caitlin who stated, '... a lot of time because during winter I think we see a surge of patients who need BiPAP, we have it every day' and Kat who identified, '... probably a quarter of the time, if you added it up, because sometimes you have two patients at a time, and so, maybe four or five hundred hours a year'. Darren and Lochlan also had regular exposure to NIV. Darren described, 'I would use it on a weekly basis. If you average it out, it'd be more than on a weekly basis'. Lochlan identified '... two or three times a month, so that's about – what's that, 20 or 30 times a year'.

Compared to the number of times in a year the nurses in the small rural hospitals said they used NIV, there was a big difference. Cindy guessed she used NIV four times per year. Emily described using NIV, '*... not very often ... this year, I might have seen it twice.*' This was similar to the answer given by Tilly who stated, '*I haven't used it enough ... there's a lot of us that have only used it, clinically, once or twice*'. Jess had experienced the largest amount of exposure to NIV in her rural facility, describing she would use it, '*... in a year – probably half a dozen times, that's about all*'.

The information provided by the nurses showed that those working in rural areas were less likely to identify NIV as a treatment for acute asthma and less likely to be exposed to NIV in their practice than those working in the regional hospital. The high rate of exposure of the ICU staff in the regional facility corroborates the quantitative data that revealed 67% of patients who were treated with NIV required admission to the ICU and 18% required transfer to another facility. The nurses working within the specialty area of intensive care therefore had the opportunity for extensive exposure to NIV. Once it was identified that differences in exposure to NIV may have influenced the use of NIV in some facilities, the nurses were asked if they felt their exposure to NIV affected their confidence and ability to use NIV in their clinical practice.

The nurses working in the rural hospitals spoke of the difficulty in gaining exposure to NIV due to infrequency of use. Cindy explained:

Unfortunately, in small rural areas it's not a piece of equipment you would use every day to consolidate your knowledge and practice. So, even with those minority being able to be trained it may be three weeks before someone actually needed to use it and those minority wouldn't even be rostered so, once again, it fell down. (Cindy)

Emily had similar sentiments:

If you don't use it all the time, you don't really retain that – you retain the majority of the knowledge, but you just don't retain those little bits and pieces and when you're in a high-pressured situation where someone's screaming for breath, that – it's just very scary. (Emily)

Tilly felt the same about the nurses in her facility:

I was going to have a look at how many patients we'd had [on NIV], but not a heck of a lot. And like I said, we seem to have – we have a few more staff that do quite a few nights, so, out of those, we've probably

got four or five that have had repeated ones, up to four or five, six in their careers now ... there are no experienced NIV users. (Tilly)

She also described that limited exposure did not just affect the clinical practice of the nurses, but also had an impact on the doctors:

The doctors are getting a bit more aware of it. But they're the same ... and that would be another interesting thing to look at, of how many doctors have had exposure to it, if they all have yet, or some have not had it, or, yeah, so there's that aspect as well. (Tilly)

Jess related this broadly to many of the skills of nurses working in rural EDs:

As a rural facility, we are jack of all trades here, but we master nothing, because we don't have a specialty in any area, but we can do little bits and pieces of everything. So, I guess that makes us generalists, but not specialists in any area, and, yeah. (Jess)

Comparing the answers of the nurses working in the rural hospitals to those of nurses working in the large, regional hospital in an ICU, the ICU nurses said the reason they felt comfortable using NIV was because of the exposure they have had. Lauren explained that when she worked in a metropolitan hospital:

... you got a lot more hands-on, a lot more experience. You were saturated with exposure to it. So, that constant saturation could give you more confidence. Seeing, just a lot more experience to see how different patients responded. (Lauren)

Caitlin also felt that the reason she was confident using NIV was, '*... the number of patients I've looked after on BiPAP machines*'.

The qualitative data therefore link the finding that there was a decreased number of patients treated with NIV in smaller facilities with the finding that the small hospitals had limited exposure to severe asthma and to NIV. The nurses suggested their limited exposure affected not only their confidence using NIV but also their clinical ability to use it as a treatment as absence of use over long periods of time caused a decline in the knowledge of its application. The way the rural nurses coped with this phenomenon may be important, both for understanding the mechanisms of support for these nurses and where there may be gaps in service delivery. Due to this, the issue of support of the rural nurses was further explored.

7.3.2 The Support Available to Nurses in Rural Facilities

The exposure of the rural nurses to NIV in one year was, in some cases, the same as the exposure of the regional nurses to NIV in one week. The rural nurses were asked how they had

facilitated care of patients on NIV when they had little exposure to the treatment and long periods in which NIV was not used. As so many of their patients were transferred to other facilities and more than half required admission to an ICU, there was a question remaining as to where support for the rural nurses would come from.

The nurses answered that they relied on the support of the ED and ICU in the large regional facility in the form of both official medical and nursing consults and unofficial calls for advice. In 2015, there was also the introduction of a critical care advisory service in the area in which this research was undertaken. Several of the nurses commented that they used this service for assistance with NIV treatment. Jess described a situation where the staff rostered on in her facility were completely guided, using the telehealth camera:

They were guided by the camera. So, it worked in the end, they got it going. They didn't know how to turn it on, didn't know how to plug it in, no idea how to use [the NIV machine]. (Jess)

There were, however, some issues due to the restricted hours of the critical care advisory service which often meant the nurses had to refer back to the large regional facility anyway. Tilly mentioned that many of the emergencies she experienced in her rural facility occurred overnight when the service was closed. Emily also raised this issue, stating that, although the critical care advisory service was helpful, it did not exist overnight so the nurses remained alone during this time. The other issue raised by Cindy was regarding the delays in using technology:

I know you can liaise with [regional hospital] and you can use the ... camera to talk to the critical advisory team, but you've still got delays there in trying to actually get onto people if they are already on phones or [regional hospital] is busy. (Cindy)

The nurses working rurally showed how, despite low levels of exposure to acute asthma and the use of NIV, they were able to use NIV with the support of the large regional facility and the critical care advisory service. It is likely that this support did not fully compensate for the detrimental effect of limited exposure to NIV, evidenced by the decreased likelihood that patients in rural areas would receive NIV for the treatment of their asthma. It was, however, identified by the nurses as an important adjunct to their practice.

7.4 The Nurses Relied on Both Subjective and Objective Measures of Respiratory Failure

The qualitative data that were used to explore elements of the quantitative findings also added elements to the results that would otherwise not have surfaced. As a nurse who has continued working in clinical practice, the researcher was aware that particular elements of what may be considered ideal practice, and outlined as such in policy and procedures, are not always adhered to in ‘the real world’. This further emphasised the importance of adding a qualitative element to this research project. Quantitative data can only reach the elements of what should occur in clinical practice and what does occur. Qualitative data can explore why practices occur. As was discovered in this project, there were many practices occurring clinically that were in addition or direct contradiction to what was recommended or explained in the literature. The first of these relates to the measurement of acute respiratory failure using biometric measures such as pH, pCO₂ and respiratory rate.

Measurements of patients’ pH, pCO₂ and respiratory rate are all routinely collected during an admission with acute respiratory failure. The reason for this is so clinicians can determine how severe a patient’s respiratory failure is, or if they deteriorate, or if their respiratory failure is improving. The quantitative data collected in this project reflected this knowledge and aimed to measure patients’ respiratory status via these biometric measurements. However, when data were collected, it was evident that these measurements were not recorded as routinely as was anticipated. To explore this, the nurses were all asked how they determined if their patient was getting better or worse when they were on NIV. Interestingly, few of the nurses reported relying solely on these biometric measurements and some did not mention the use of pH, pCO₂ or respiratory rate to determine how unwell a patient was.

When asked how she determined if a patient was getting better or worse, Cindy replied:

I think it would be like their work of breathing and their observations in total, not only like their vital signs but obviously how they’re actually presenting because I mean with their work of breathing they get quite exhausted and it gets to a stage that they just can’t do it anymore.
(Cindy)

Lochlan gave a long, thorough answer incorporating a full clinical assessment, but began his assessment with, ‘... the predominant one is, do they look comfortable on the BiPAP?’. Darren gave a similarly thorough answer beginning with:

It's a holistic assessment. Generally, are they speaking in words, phrases, sentences, what. What's their breathing effort, are they using accessory muscles. (Darren)

Tilly answered by saying she relied on the holistic clinical picture and emphasised that other measurements were complementary.

The other nurses who stated they used blood gases (measurements of pH and pCO₂) to determine how unwell their patients were had other priorities first. Emily was one such nurse:

You can see that hopefully they're relaxing, their work of breathing's relaxing and they might be pinking up and then observations are starting to look more in the normal zones. We do some blood gases too, and look at that and just the whole – patient's whole sort of body posture. (Emily)

Lauren, too, put work of breathing first:

Work of breathing, respirations, saturations, blood gases, whether the patient is, you know, becoming comfortable and a relief of symptoms on noninvasive or if they're becoming more and more anxious and still struggling to breathe despite the NIV. (Lauren)

As did Caitlin:

First and foremost ... observe the patient if their work of breathing is improved or getting worse, their respiratory rate if it's getting higher they're getting worse. If it's improved along with the reduced work of breathing they're improving. And also, the blood gas results, arterial blood gas results will give us guidance as to whether your patient is improving or worsening. (Caitlin)

Jess had a similar method of assessment:

She [the patient] improves overall ... increased work of breathing is reducing and she's more comfortable, she looks comfortable, yeah, so it's pretty obvious if it's working or not. And, again, the venous blood gas results. (Jess)

Using blood gases to determine a patient's respiratory status seemed to add an element of difficulty due to analysis, as was discussed with Emily when she was asked if she was comfortable to read blood gases:

I wouldn't say comfortable, no, because I don't do it enough ... I sort of know some of the values in there ... but I couldn't say, "Oh, they're in respiratory acidosis" straightaway. I'd have to get out a little chart, probably, but only because I haven't – you don't do it all the time, but yeah. (Emily)

It is possible that the extra time required for analysis of blood gases resulted in these measurements being used infrequently in clinical practice during acute respiratory failure. Work of breathing was the indicator most of the nurses relied on but it was not a clinical finding that was routinely recorded in any of the sites in which data were collected. It was also evident from the nurses' answers that they employed a sort of intuition when assessing their patients, as was discussed in Chapter 6. Many of them described assessing their patients by *looking at them*. This is not something that would have been captured by the quantitative data and provides an answer as to why there were many blood gas values missing during quantitative data collection.

7.5 Clinicians Feel that NIV is a Useful Clinical Tool

Quantitative research is beneficial in its ability to define the extent of the benefit of particular treatments. In this project, the quantitative data showed the ability of NIV to benefit patients with acute exacerbations of asthma and demonstrated no adverse effects when administering NIV to this patient group. While it is important to understand the efficacy of a treatment for a particular condition, this is of little consequence if there is no understanding of the experiences of clinicians using that treatment. What is considered a good treatment may in practice be unrealistic for use due to the constraints of resources and training within the healthcare environment. For this reason, the nurses were asked how they felt about NIV as a clinical tool. Cindy replied:

I think it's a great piece of equipment and that we've actually reduced transfers to [regional hospital] by utilising it and I think that's probably best for the patient and that patient has had a better outcome. (Cindy)

When asked if she thought NIV was a good clinical tool, Emily responded:

I can see that it's an amazing bit of equipment and, like I said, we haven't had – I mean, that one lady had to be intubated but it still got her to Wagga. It got her to more definitive care where there were people who've got more experience with that sort of thing, so, I do. I think there's always really good outcomes. (Emily)

Lauren felt the same, *'I think that it's a good intervention to use for a certain population. Yeah, I like using it'*. As did Darren:

I think there's a lot of scope, there's so much potential with NIV what I can do, with people with lung disease, it's about harnessing I guess and using it appropriately. (Darren)

This shows that despite the issues identified by the nurses which affected their practice, many of the nurses overcame these adversities and felt that NIV was a useful clinical tool. This is linked to the quantitative finding that NIV was a safe treatment that did not result in any adverse effects or mortality in this study population. Considering the nurses felt that NIV was a good clinical tool – and in this research it was shown to be an appropriate treatment for acute asthma – the contextual issues raised by the nurses are important in the understanding of treatment discrepancies.

7.6 Chapter Summary

This chapter has demonstrated that despite the availability of NIV, guidelines to govern its use and patients who required this treatment, there were several contextual factors that led to a variability in clinical practice. The qualitative data have enriched the quantitative data by exploring the context of practice. The nurses identified several reasons that may explain why NIV was administered to 63% of the eligible patients with acute exacerbations of asthma. They suggested that adherence to guidelines, skill mix and time of day had an effect on their ability to provide NIV treatment. The nurses also explained that the way they were introduced and educated on the use of NIV affected their practice, as did their exposure to the treatment which was related to the size of the facility in which they worked. It was also evident that for the initiation of NIV, collaboration among doctors and nurses was important. In addition to these explanations, the qualitative data provided information that was an adjunct to what was found quantitatively. They suggested that work of breathing was the most important measurement of respiratory failure and was often, but not always, complemented by biometric values. The nurses also stated that they found NIV to be a good clinical tool. This concludes the results of this research project. The quantitative and qualitative results have been presented as independent entities in Chapters 5 and 6. This chapter has shown the direct links and points of integration of the two data sets which complemented one another. The next chapter will focus on a discussion of the results of this research project.

Chapter 8: Discussion

8.1 Introduction

This chapter explores and integrates the quantitative and qualitative results presented in Chapters 5, 6 and 7. The results of this project indicate that NIV may provide better clinical outcomes for adult patients with acute exacerbations of asthma compared to standard medical therapy. Measurement of patients' pH and pCO₂ at zero, four and 18 hours showed no difference between NIV and standard medical therapy, but respiratory rate was significantly improved in the NIV group. The outcomes were affected by multiple covariates including age, sex and COPD. There were no adverse effects associated with the use of NIV and there was no mortality in the group of patients who received NIV or those who did not. Importantly, this study also showed that despite a published procedure advocating for the use of NIV for acute asthma, only 63% of patients who met the criteria for NIV received it as a treatment. The interviews conducted with nurses were able to provide insight into the reasons why this may have occurred. The nurses also explained the contextual constraints on their practice which inherently affected patient care.

In this chapter, the results of the project will be contextualised and compared to research that has examined similar issues. Possible explanations for findings will be identified. This will begin with an examination of the study population, the biometric findings and influences of covariates on the outcomes of the patients. Information provided by the nurses in the semi-structured interviews will be used, where possible, to provide explanations or examples to enrich the discussion. Finally, the reasons for the use or absence of NIV will be examined in relation to the path to clinical intuition described by the nurses.

8.2 Contextualisation of the Quantitative Findings of this Study

The number of hospitalisations in the nine sites due to acute exacerbations of asthma in the five-year period of this study was 1656. In the large, regional hospital, asthma admissions accounted for 0.51% of all the hospital admissions as averaged across five of the six years reported in the hospital's patient admission data (AIHW, 2018). This is higher than the reported rate for the MLHD as a whole in which asthma admissions accounted for between 0.25% and 0.29% in the same time period. This is probably a reflection of the large catchment area accounted for by the regional hospital, which is the largest facility in the MLHD (AIHW, 2018).

This study also recorded a higher proportion of females admitted to hospital with severe asthma compared to males, with 67% of the study population recorded as female. The higher prevalence of asthma in women in the MLHD corroborates the nation-wide statistics that demonstrate asthma in Australia is more prevalent in women than men (10.9% compared to 8.9%) (ACAM, 2011).

The percentage of total adult asthma admissions recorded in this project that were classified as severe varied across the years but averaged 2.1%. Of the total number of patients who were admitted to hospital with a severe exacerbation of asthma, 56% required admission to an ICU. This is notably higher than the rate of 30% reported in an Australian study by Pallin et al. (2015) although this may be attributable to differences in the study designs and locations. Pallin et al. (2015) used a control group, who did not require ventilatory support, by matching age, gender and body mass index instead of matching patients according to asthma severity, as was done in this study. As a result, the researchers only had two patients in their control group of 90 who required ICU admission (Pallin et al., 2015), compared to 24 (of the 66 patients who were followed to discharge) in this study. It should also be taken into account that the study conducted by Pallin et al. (2015) was undertaken in a large, tertiary hospital compared to the present study which examined rural and regional hospitals. Most rural and regional hospitals do not have the capability of monitoring patients with acute respiratory failure outside of the ICU.

The most prevalent comorbidities reported in the patients with asthma in this study were allergies, hypertension, gastro-oesophageal reflux disease, hypercholesterolaemia, diabetes, arthritis and depression/anxiety. Asthma and other allergies are inherently linked due to their shared immune-mediated response so it is unsurprising allergies were the highest recorded comorbidity in this population (Liu et al., 2010; Liu et al., 2017). The presence of gastro-oesophageal reflux disease has also been linked with a diagnosis of asthma and the coexistence of the conditions are thought to cause mutual exacerbations (Pruitt, 2016). Previous research has shown that treatment of gastro-oesophageal reflux disease may alleviate the symptoms of asthma (Sandur et al., 2014). In this study, concurrent treatment of gastro-oesophageal reflux disease was not investigated but the association between a diagnosis of gastro-oesophageal reflux disease and severe asthma is notable and may be worthy of investigation in the local area.

Other comorbidities such as hypertension and diabetes have previously been recorded in patients who presented to hospital with acute exacerbations of asthma (Adams et al., 2006; Pendergraft et al., 2004). Although the association of diabetes and asthma may be contentious, as a more recent Australian report showed there was no association between asthma and diabetes in the national population in 2007–2008 (ACAM, 2011). The results of this study indicate that diabetes may be a notable comorbid disease for patients with severe asthma in the MLHD. Other findings from this project do corroborate the results of the 2011 report by ACAM such as the high incidence of mental illness and behavioural problems reported in asthmatic patients, as well as high rates of arthritis. The significance of comorbidities present in people with a diagnosis of asthma is the influence this has on their overall health. The presence of comorbidities often complicates asthma treatment, affects quality of life and increases dependence on medical care (ACAM, 2011).

The reported number of patients admitted to hospital with an acute exacerbation of asthma in this study who were current smokers was 27%. This is higher than the estimated number of people who smoke in the general population of the MLHD which is estimated to have dropped from 21.6% in 2010 to 18.5% in 2015 (NSW Ministry of Health, 2017e). The high rate of current smoking found in asthmatics in this project corroborates previous data collected nationally and internationally. A report in 2001 showed that in the MLHD, 22.2 people per 1000 population had asthma and concurrently smoked. This was slightly higher than the Australia-wide rate of 22.4% in 2001 (ABS, 2017). In 1995, a South Australian study reported that the smoking rate in people with current asthma was 28% (Wakefield, Ruffin, Campbell, Roberts, & Wilson, 1995). Internationally, a study conducted across North America and Canada reported that 35% of asthmatics who presented to EDs were current smokers (Silverman, Boudreaux, Woodruff, Clark, & Camargo, 2003). Rates of 20–30% had been reported in Canada (Canada, 2001). In the UK, the rate of current smoking in asthmatics has been estimated at around 30% (Althuis, Sexton, & Prybylski, 1999).

The epidemiological study on the genetics and environment of asthma examined the role of smoking as a risk factor for bronchial hyperresponsiveness and atopy in asthmatics (Siroux, Pin, Oryszczyn, Le Moual, & Kauffmann, 2000). They found that active smoking was related to asthma severity and current smokers had more asthma symptoms and asthma attacks than non-smokers (Siroux et al., 2000). It is widely recognised that people with asthma who concurrently smoke suffer from more severe symptoms and an accelerated decline in lung

function than people with asthma who do not smoke (Chaudhuri et al., 2006; Tamimi, Serdarevic, & Hanania, 2012). As a result, people with asthma who smoke are more likely to have uncontrolled symptoms requiring hospitalisation (Osborne et al., 2007; Silverman et al., 2003; Thomson & Chaudhuri, 2009). Cigarette smoking has also been identified as a risk factor for near fatal asthma (Choi, Park, Jang, Kang, & Lim, 1999). Further, research has identified that asthmatics who smoke or have previously smoked are not as responsive to short-term corticosteroid treatment as asthmatics who have never smoked (Chaudhuri et al., 2003; Lazarus et al., 2007; Tomlinson et al., 2005). People who smoke and have asthma are also not as responsive to high-dose corticosteroids (Pedersen, Dahl, Karlström, Peterson, & Venge, 1996).

Little is known regarding the reasons why asthmatics smoke. One identified possibility is that asthmatics smoke as a mechanism to cope with their chronic illness and to gain feelings of control (Avallone et al., 2013). High rates of smoking among people with asthma might also be related to their self-rated poor psychological health (Hasler et al., 2005). High levels of distress have been shown to be related to unsuccessful quitting attempts (Brown, Lejuez, Kahler, & Strong, 2002). Due to the negative effects of cigarette smoking on asthmatics such as the increase in morbidity, mortality and insufficiency of treatments, research focused on why asthmatics smoke and primary health interventions to modify this risk factor should be addressed. The high rate of smoking present in people presenting to hospital with acute exacerbations of asthma in the MLHD may need to be addressed in this health district.

8.3 Difficulties Encountered in Study Inclusion and Exclusion Criteria

One of the difficulties in the design of this project was the formulation of the inclusion and exclusion criteria. It has previously been recognised that due to the complex pathophysiology of asthma it is difficult to identify a specific window for mechanical ventilation (either invasive or NIV) (Scala, 2010). Research has reported a variable need for mechanical ventilation based on hypercapnia during episodes of asthma, ranging from 8–50% (Scala, 2010). Mechanical ventilation may also be required for asthmatics who have not yet reached a state of hypercapnia (Scala, 2010). Additionally, asthmatics can show signs of alkalosis rather than acidosis in the preliminary stages of an acute exacerbation due to the loss of CO₂ during hyperventilation. The heterogeneous nature of asthma exacerbations makes it difficult to define specific criteria to class them by severity (Raimondi, Gonzalez, Zaltsman, & Menga, 2014).

The inclusion criteria in this study were based on that of the MLHD adult procedure for NIV which outlines specific biometric values on blood gas analysis that indicate the requirement for respiratory support (Green & Haworth, 2015). The biometric inclusion criteria could not be used in isolation in this project due to the absence of these measurements in some sites. For example, many of the rural sites do not automatically collect blood samples for analysis on patients with acute respiratory failure. To address this issue, adjunct criteria had to be formulated so that patients with asthma who required NIV were included in the study, regardless of whether they had blood samples collected and analysed.

Other researchers who have retrospectively examined acute asthma have had similar difficulties due to the variation in practice between different healthcare providers (Pallin et al., 2015). To account for this, in addition to the inclusion criteria outlined in the MLHD adult procedure for NIV, a second category of inclusion criteria was designed (outlined in Chapter 4). Inclusion criteria in Category 2 included a respiratory rate > 30 breaths per minute and documentation by the admitting physician of asthma that was ‘severe’, ‘extremis’, or ‘able to speak one word at a time’ (Tuxen & Naughton, 2009). The Category 2 inclusion criteria posed their own difficulties as they relied on physicians to diagnose and document severe asthma. This can be problematic due to variances in physician practice and diagnosis, as has been found by several other researchers (Nanchal et al., 2013; Pallin et al., 2015).

An alternative method of determining the severity of acute asthma which was considered is through the use of spirometry, a device that allows a clinician to measure airway obstruction (Hanlon, 2017). This poses difficulty in the case of severe acute asthma, as the patient may not be stable enough to provide the large breath required for a recording. Although others have demonstrated the use of spirometry to guide treatment of patients with acute asthma (Brandão et al., 2009; Saint-Jean, de Rohan Chabot, Thaler, & Loirat, 1987; Silverman, Flaster, Enright, & Simonson, 2007), in this project, spirometry was used for 11% of the patients with acute asthma so was unable to be used for the purpose of deciding who to include as patients in the study. The low rates of spirometry use may have been due to difficulty obtaining readings in unstable patients, or may reflect that the clinicians’ primary focus was on treatment (Raimondi et al., 2014). There has also been some research that has shown spirometry manoeuvres may be detrimental during mild exacerbations of asthma and COPD, causing an increase in airway resistance (Fabbri, Paredi, Sally, Martyn, & Usmani, 2016). The significance of the difficulty in designing inclusion and exclusion criteria for studies focused on acute asthma is that these

parameters affect the type and number of patients who will be admitted to a study, thus influencing the generalisability of the results. It is imperative that researchers are aware of the type of biometric measurements undertaken in facilities proposed for inclusion in retrospective studies so that the patients included accurately reflect the asthma population in that hospital or area.

8.4 Influences on Admissions and Outcomes

The results of the quantitative data analysis showed there were several covariates that affected admissions and outcomes of patients included in this study. There was a significant effect of ‘year’ on the number of presentations of asthma across the hospitals from which data were collected. In particular, 2012 had a notably higher number of asthma admissions compared to the other years studied. There were many variables that may have affected the number of asthma hospitalisations in 2012 that were not able to be recorded as part of this project, including healthcare context (i.e. staffing, primary healthcare provision) and individual context. Factors that may have influenced an acute asthma attack that had been recorded by other institutions were examined for possible relationships to the high number of asthma hospitalisations seen in 2012.

The overall health of the Murrumbidgee population was examined across the study period to determine if any other health factors peaked in 2012, particularly those that may have had an influence on asthma hospitalisations. The most likely influence on the higher rates of asthma hospitalisation in 2012 was that this year had the highest percentage of adults diagnosed with current asthma, recorded as 15.7% (NSW Ministry of Health, 2017d). Smoking rates also peaked in 2012 with 21.9% of the Murrumbidgee population recorded as currently smoking (NSW Ministry of Health, 2017e). Average annual pollen count data were only available for the large regional centre between 2012 and 2015, but the recordings did demonstrate that 2012 had the highest average annual count for particles less than 2.5 micrometres in diameter ($\mu\text{g}/\text{m}^3$) (Office of Environment and Heritage NSW, 2017). The prevalence of asthma in adults, smoking rate and pollen counts are the only demonstrable data found that may have contributed to the high rates of asthma admissions in 2012.

Other factors that were considered were rates of obesity, rates of influenza, socioeconomic disadvantage and household smoking rates. Across the five-year period in which this study was undertaken, obesity levels in the Murrumbidgee area were lowest in 2012 (NSW Ministry of

Health, 2017g) and the number of hospitalisations due to influenza and pneumonia were also at their lowest in the 2012–2013 financial year (NSW Ministry of Health, 2017f). No relationship was seen between 2012 and hospitalisation due to socioeconomic disadvantage or household smoke exposure rates (NSW Ministry of Health, 2017c, 2017h).

Regarding trends across individual hospitals, the data demonstrated that Hospital D trended towards having the highest percentage of admissions for acute exacerbations of asthma. Reasons were investigated to deduce a possible cause for this anomaly. No data were found that isolated relevant patient demographics in this town. Hospital D was located in the lower half of the Murrumbidgee local government area in regard to socioeconomic disadvantage score (Gilchrist, 2013), but had no uniquely identifiable reasons for having a high rate of admissions of acute exacerbations of asthma.

8.4.1 pH and pCO₂

This research demonstrated the effect of several covariates on the outcomes of patients with acute exacerbations of asthma admitted to the hospitals in this study between 2010 and 2015. The first outcomes examined were the pH and pCO₂ measured at zero, four and 18 hours. In this study, the use of NIV did not have an effect on pH or pCO₂. Gupta et al. (2010) also found no difference in pH or pCO₂ when they examined patients with acute asthma treated with NIV compared to those treated with standard medical therapy. Despite the inability to show NIV significantly affected pH and pCO₂ compared to standard medical therapy, a change in pH and pCO₂ from baseline has been reported by Meduri et al. (1996). This indicates that NIV has the ability to rectify acute respiratory failure.

Patients' age had a significant effect on pH and pCO₂ with significantly lower pH levels and higher pCO₂ levels recorded with increasing age. This was previously reported in a study by Köse et al. (2014) who examined the results from arterial blood gas analyses in the ED and found that acid-base disorders increased as age increased. The high incidence of acid-base disorders in older people has been suggested to be a result of the physiological effect of ageing on the acid-base system (Nabata, Morimoto, & Ogihara, 1992). The body relies on respiratory and kidney function to maintain appropriate acid-base balance and these systems are often impaired in those who are older. Older people may also be affected by taking a large number of prescribed medications which influence these body systems (Nabata et al., 1992; Tareen et al., 2004). The lower pH levels identified in the older patients may also have been a result of

concurrent COPD diagnosis which, in this study, was present in four patients (average age 79 years). Despite presenting with lower pH levels, the older patients recovered from their acute respiratory failure at the same rate as those who were younger. This indicates that although the older patients presented to hospital with worse acidosis, they were able to respond to treatment within the same time frame as younger patients.

Inclusion in this study coincidentally resulted in recruitment of patients who had asthma-COPD overlap. The patients with asthma-COPD overlap had significantly lower pH levels and significantly higher pCO₂ levels compared to the patients without asthma-COPD overlap. This may have occurred because the primary pathophysiological manifestation of an acute exacerbation of COPD is hypercapnia and associated acidosis (O'Donnell & Parker, 2006). This may have affected the efficacy of the treatment with NIV in a positive way. There has been a plethora of data published on the ability of NIV to successfully treat acute exacerbations of COPD (Osadnik et al., 2017). Interestingly, the patients with asthma-COPD overlap also had longer ICU length of stay than the patients without COPD. This may have been a result of the burden of their comorbidity.

8.4.2 Respiratory Rate

Treatment with NIV had a significant effect on patients' respiratory rates in this study. This finding replicates the reports of other researchers who have demonstrated a significant effect of NIV on respiratory rate when compared to standard medical therapy (Soroksky et al., 2003). Galindo-Filho et al. (2013) found in their prospective study of NIV coupled with nebulisation that respiratory rate was significantly decreased in the NIV group. Interestingly, the radio-aerosol lung deposition of nebulised particles was not significantly different between the groups so the effect could not be attributed to the combination of NIV and nebulisation, but perhaps was due only to the use of NIV. Brandão et al. (2009) also coupled NIV with nebulisation and found that, in the NIV group with higher pressures, respiratory rate had significantly improved compared to baseline, although there was no statistical difference between the treatment and control groups. Pallin et al. (2015) also demonstrated that the use of NIV reduced the respiratory rates of patients with acute asthma compared to baseline.

Despite the significant effect of NIV on respiratory rates found in this research, the results also showed that the effect of the interaction of time was significant in this analysis and thus the improvement in the patient's acute exacerbation of asthma was at least partially due to the

passing of time. This effect has not been reported by other researchers but there have been studies that have found no significant effect of NIV on respiratory rate. Gupta et al. (2010) found the NIV and standard medical therapy groups both had significantly improved respiratory rates but there was no statistical difference between the groups. They did, however, find that the NIV group trended towards greater improvement in work of breathing (Gupta et al., 2010). This was a replication of the findings of Soma et al. (2008) who reported that the use of NIV compared to standard medical therapy did not result in differences in respiratory rates but did improve work of breathing. Pollack et al. (2001) found that the use of NIV did not affect respiratory rates, however, their study sample included patients with mild to moderate asthma and they uniquely used nasal masks for the application of NIV which posed the risk of losing therapeutic pressures.

The finding of reduced respiratory rates in patients with acute exacerbations of asthma who were treated with NIV may have clinical significance. Work of breathing is a significant cause of distress in patients with acute respiratory failure. Respiratory rate is one component of work of breathing and generally, as work of breathing increases, so too does respiratory rate (until the patient becomes exhausted). Respiratory rate may be a composite measure of patient comfort. The reduction of respiratory rate resulting from treatment with NIV may lessen the distress of patients and increase their comfort. Other studies that have measured the effect of NIV on work of breathing have recorded that the use of NIV significantly decreased work of breathing in patients with acute asthma (Chaudhry et al., 2010; Soma et al., 2008).

It is notable that when the nurses were asked how they determined if their patient was deteriorating or improving all of them identified respiratory rate and work of breathing as important factors. Lochlan even described being able to differentiate between when a patient was deteriorating, getting better, or too exhausted to breathe. Interestingly, scientific literature also points to respiratory rate as being one of the most reliable indicators of patient deterioration (Cretikos et al., 2008; Parkes, 2011). If nurses are able to determine a patient's status based on their respiratory rate and work of breathing then the interaction between NIV and these factors may be worthy of further exploration.

The findings of this study corroborate those of other researchers who have demonstrated that the first four hours of treatment with NIV result in the most significant improvement in biometric measurements (Soroksky et al., 2003). Meduri et al. (1996) demonstrated this effect within the first two hours of NIV treatment. What this may mean for clinical practice is that if

there is no improvement in a patient in the first four hours of treatment with NIV, it is possible that NIV will be of no benefit to the patient and they may require escalation to invasive mechanical ventilation. This is not a definitive timeline, however, as research has shown a potential for patients to deteriorate within two hours of NIV initiation (Gupta et al., 2010). The results of this study also demonstrate that the lower the number of hours between presentation and NIV commencement, the lower the patient's predicted mean respiratory rate will be at 18 hours. This indicates the importance of initiating treatment as soon as a patient is identified as requiring respiratory support.

8.4.3 ICU and Hospital Length of Stay

There were several covariates in this study that had an effect on ICU and hospital length of stay. ICU length of stay was significantly longer for patients who were treated with NIV compared to those who received standard medical therapy only. There may be several reasons for this. The patients who received NIV were clinically more unwell than the patients who did not receive NIV. They had a higher average heart rate, lower mean arterial pressure (blood pressure) and higher Acute Physiology and Chronic Health Evaluation II scores. The presence of severely abnormal clinical measurements may indicate that the patients who received NIV were systemically more unwell than those who did not receive NIV (Tuxen & Naughton, 2009). Higher Acute Physiology and Chronic Health Evaluation II scores have also been previously linked with high rates of mortality in patients who present to hospital with acute respiratory failure (Gaud et al., 2016). ICU length of stay also may not be an adequate indication of illness due to the multitude of factors that impact this value, regardless of a patient's illness. In the context of the area in which this study was conducted, treatment of acute respiratory failure with NIV is generally provided in the ICU, but for asthma exacerbations that require respiratory support ICU admission is mandatory (Green & Haworth, 2015). This is not the case for treatment with standard medical therapy which could be delivered in settings outside of the ICU. Thus, the mandatory requirement for NIV to be delivered in ICU would have an effect on length of stay for those patients. Further, ICU length of stay is often affected by bed block, a phenomenon in which a patient is medically fit to be cared for in a ward setting but cannot be discharged from ICU due to the absence of an available ward bed (Lin, Chaboyer, & Wallis, 2009).

Treatment with NIV also had an effect on hospital length of stay. This study found that for every hour a patient was treated with NIV, their length of hospital stay increased by 3.5 hours.

Other studies have had similar findings. Pallin et al. (2015) reported that patients who received NIV had longer hospital admissions than those who received standard medical therapy only. This may have been an expected outcome of their study though, considering the control group was matched for age, gender and body mass index only, and not for asthma severity (Pallin et al., 2015). Soroksky et al. (2003) similarly reported a trend in longer hospital length of stay for patients who received NIV compared to a control group but were unable to show statistical significance.

Interestingly, Gupta et al. (2010) reported decreased hospital and ICU length of stay for the patients who received NIV compared to those who received standard medical therapy only. This may be because their prospective study was able to match the treatment and control groups for asthma severity (Gupta et al., 2010). Murase et al. (2010) compared a cohort of patients with asthma prior to the implementation of NIV in their hospital to a similar cohort post the introduction of NIV in their facility and reported a similar ICU length of stay in both groups but a significantly shorter hospital length of stay for the group post introduction of NIV. It is difficult to draw conclusions regarding the effect of NIV on length of stay from the study by Murase et al. (2010), however, because the passing of time between cohorts would inherently result in changes in hospital and intensive care practice. The results of Murase et al.'s study (2010) therefore may not be an adequate indication of the relationship between NIV and length of stay.

The results of this study showed females had a predicted mean hospital length of stay of 6.5 days compared to 4.4 days for males. Increased length of hospital stay recorded for women has been found in several other studies that have examined asthma (AlMarri, 2006; Gehlbach et al., 2002; Skobeloff, Spivey, St Clair, & Schoffstall, 1992). This may be due to the higher prevalence of asthma in females as compared to males and the increased severity of their disease (Dolan et al., 2004; Smith et al., 2009). Lin, Ji, and Liao (2013) reported similar findings when they investigated sex-specific hospitalisation rates for adults in the United States. They noted that women in their 50s and 60s were significantly more likely to be admitted to hospital with acute asthma compared to men of the same age (Lin et al., 2013).

8.4.4 Mortality

Mortality was a primary outcome of interest in this project. Although the mortality rate for patients admitted to hospital with acute exacerbations of asthma has previously been estimated

at 0.28% (Nanchal et al., 2013), this project was unable to demonstrate a relationship between asthma, NIV and mortality as there were no deaths recorded in the group of patients who received NIV or those who did not. Other studies have also found no mortality in groups who received NIV compared to those who did not (Murase et al., 2010; Gupta et al., 2010; Meduri et al., 1996). This may be due to the generally low rates of mortality found in asthma (Scala, 2010). Studies that have been able to demonstrate mortality rates for patients with acute exacerbations of asthma have done so using large retrospective databases (Nanchal et al., 2013; Pendergraft et al., 2004). Design of future studies should take this into consideration and focus on large, national databases for the purpose of determining mortality rates in asthma.

8.5 NIV Mode

The most common type of NIV mode used for treatment in this project was BiPAP which was used for 58% of all patients. This reflects the published evidence that has examined the use of NIV for acute exacerbations of asthma as most studies have focused solely on the use of BiPAP, either retrospectively or prospectively (Soma et al., 2008; Meduri et al., 1996; Pallin et al., 2015; Soroksky et al., 2003). BiPAP is an appropriate treatment for asthma because the two levels of pressure allow for both oxygenation and a reduction in CO₂. It also alleviates work of breathing which is a significant consideration in asthma (Duke & Bersten, 2009). In this study, CPAP pressure was used in 1% of patients and both BiPAP and CPAP were used in 4% of the patients. This may represent initial treatment of hypoxia only, misdiagnosis or initial inability to determine asthma as the primary cause of illness, or clinician misunderstanding regarding the physiology of NIV treatment.

8.6 The Location of NIV Treatment

In this project, the use of NIV for acute asthma was examined in critical care areas including ICU, HDU and the ED. This was due to the local guideline stipulation that NIV should only be provided in these areas (Green & Haworth, 2015). When the nurses were interviewed, several of them stated that in some cases in their facilities NIV was used in ward areas, but this was a rarity and the use of NIV was generally reserved for critical care areas. This corroborated the quantitative data that showed the area with the highest frequency of NIV use was the ED, followed by the ICU, then the HDU. Despite some of the nurses identifying that NIV was occasionally used in ward areas, most of them recognised that while this was feasible, it was not desirable in the current healthcare context.

The use of NIV in general wards is currently contentious. It has been recognised that although the use of NIV is encroaching into the wards, there is little evidence to suggest this is safe (Olivieri et al., 2015). It has been suggested that part of the reason NIV treatment is becoming more commonly used in ward settings is due to the shortage of ICU beds (Olivieri et al., 2015; Stelfox et al., 2012). The ICU bed shortage is a significant, international problem (Fiorino et al., 2010). Limited ICU beds have been shown to have an effect on both the likelihood a patient treated with NIV in the ward setting is admitted to the ICU and the likelihood they receive treatment that requires ICU care, such as ventilation (Nagendran, de Silva, & Harris, 2015). The push for patients to be treated with NIV in ward settings also poses financial savings compared to treating these patients in the ICU (Plant, Owen, Parrott, & Elliott, 2003).

It has previously been reported that for patients with hypercapnic respiratory failure who do not meet any other criteria for ICU admission, treatment with NIV on the wards is feasible (Olivieri et al., 2015). In the study by Olivieri et al. (2015), NIV was successfully used on a medical ward by trained nursing and medical staff. More recently, a retrospective study examined the long-term survival of patients treated with NIV in ward settings and found no significant difference in mortality rates compared to survival rates of patients treated with NIV in the ICU (Cabrini et al., 2016). The study by Cabrini et al. (2016) was undertaken in a single teaching hospital in which the ward-based NIV service was led by the ICU team. During treatment of the patients on the ward, the medical emergency team was available 24/7 for clinical consultation and attended routine visits to assess the patients (Cabrini et al., 2016). Periodic training was offered to the ward staff using NIV, although not all the staff attended this training. Other studies that have examined the use of NIV in ward settings have provided the nursing staff with training and access to an NIV team which leads the treatment (Dave et al., 2014; Plant et al., 2000).

These research projects indicate that NIV treatment may be safely used in ward settings in some facilities. The context of the facility is imperative for any hospital considering a ward NIV service. Unlike ICU settings, where patients are nursed at a ratio of 1:1 or 1:2, in general wards patients are nursed at much higher ratios (Australian Nursing and Midwifery Federation, 2014; Chellam, 2010; Queensland Health, 2016). It should also be recognised that despite the evidence that suggests NIV may be a safe treatment to provide on the wards under the care of trained staff, these studies have mostly focused on the treatment of patients with acute exacerbations of chronic hypercapnic respiratory failure such as COPD (Cabrini et al., 2016;

Dave et al., 2014; Fiorino et al., 2010), or those for whom NIV is the ceiling of treatment (Corral-Gudino et al., 2011). This then, may not be transferrable to treatment of asthma.

Another consideration is that while the use of NIV in wards in large metropolitan hospitals may be appropriate due to the presence of specialist teams and training, this is not the case in rural and regional areas. The nurses interviewed in this project unanimously felt that using NIV in ward areas in their hospitals would not be sustainable due to the inadequacy of resources and infrastructure. This has previously been shown by Cabrini et al. (2009) who used questionnaires to determine the perspectives of nurses working on wards where NIV was used. The majority of the ward nurses felt they were not involved in decision-making or consultations and were inadequately informed about the use of NIV (Cabrini et al., 2009). Only 13% of the nurses stated their training was adequate (0% in medical wards) (Cabrini et al., 2009, p. 429). The difference between prospective studies that show the use of NIV in wards is safe and retrospective studies that show nurses do not feel that this practice is safe should be taken into consideration by any facility examining the location of their NIV service.

There is a significant difference between respiratory wards in metropolitan hospitals and general wards in regional and rural hospitals. Caution should be exercised when attempting to govern clinical practice as significant variability exists in different healthcare facilities, particularly in reference to rural versus regional and metropolitan areas. Nurses in rural areas have previously expressed that metropolitan hospitals often expect them to perform the same tasks without realising the resource constraints they must work within (Wolf & Delao, 2013). This is also an issue in the context of governance, where large regional and metropolitan hospitals often design procedures and policy without consideration for the resource constraints that affect small, rural hospitals (Paliadelis, Parmenter, Parker, Giles, & Higgins, 2012). Large hospitals cannot expect small hospitals with limited ventilators and no specialist staff to provide the same NIV service (MacLeod, Browne, & Leipert, 1998).

8.7 Not All Patients Received NIV

One of the most notable findings of this study was that despite the publication of procedures and guidelines for the management of NIV practice, 63% of all patients with asthma who were eligible for treatment with NIV actually received this therapy. This is similar to research conducted by Sinuff et al. (2007) who found NIV guideline adherence in their hospital was 60%. In their study, Sinuff et al. (2007) also examined the reasons for non-adherence to the

guidelines and found that physicians who used NIV outside of the guidelines generally did so with a rationale: they did not feel bound by them. They found that the most significant barrier to the use of the NIV guidelines was lack of awareness of their existence (Sinuff et al., 2007). This resonates with the qualitative results of this research, as the nurses who had not been using the guidelines stated that they did not know they existed.

Lack of adherence to the NIV guidelines is one factor that influenced the decision to use NIV in this project, however, it may not always be appropriate for clinicians to follow guidelines and procedures in practice. In Australia, clinical guidelines are defined as:

... evidence based statements that include recommendations intended to optimise patient care and assist health care practitioners to make decisions about appropriate health care for specific clinical circumstances. Clinical practice guidelines should assist clinicians and patients in shared decision making (NHMRC, 2017, para 2).

This definition stipulates the use of guidelines as an adjunct to clinical knowledge and in reference to individual patient situations. It may be appropriate in some clinical situations to deviate from guideline recommendations due to context, resources and unique patient factors. Issues in clinical practice are more likely to arise due to non-adherence to guidelines resulting from a lack of awareness that they exist. This is particularly relevant as guidelines are intended to support and assist clinicians when using skills and knowledge they do not practise regularly. Several of the nurses interviewed in this project who worked in rural areas reported frequently referring to the local procedure for NIV to guide their practice. Jess was the only rural nurse who stated she was unaware of the guideline but was grateful to be told about its existence and indicated she would begin to use it immediately. Considering the aim of guidelines and procedures is to assist clinicians and guide their practice accordingly, it may be appropriate for healthcare facilities to review the methods by which they disseminate guidelines and procedures to enable capture of a larger clinical audience.

This project found that the likelihood patients would receive NIV was significantly affected by the size of the hospital to which they presented. Patients who initially presented to the large hospital (> 200 beds) had an 80% chance of receiving NIV compared to the 43% and 42% likelihood of patients receiving NIV treatment after presentation to a medium (100–200 beds) or small hospital (< 50 beds) respectively. Several of the nurses who were interviewed identified the importance of exposure to NIV on the likelihood they would use it. The nurses working in the small hospitals described using NIV once or twice a year, compared to those

working in the large hospital who used it multiple times a week. Wolf and Delao (2013) reported that clinical staff in rural hospitals were often hesitant to perform tasks for which they had not been trained, particularly when patient presentations unfamiliar to them were involved. The context of the nurses' workplace had a notable effect on their ability to use NIV. The nurses described treatment decisions being affected by a multitude of factors including education, isolation, resources, time of day, skill mix, previous exposure and professional relationships.

The results of this research show that NIV is a safe treatment for adult patients with acute exacerbations of asthma. Compared to standard medical therapy, it is possible that NIV corrects respiratory rate more quickly, which may result in increased patient comfort. The use of NIV in this project was not a guaranteed method of treatment for adult patients with acute asthma, despite guideline stipulations that it is used for this purpose. The results of the interviews with the RNs working in areas that used NIV as a treatment enriched the quantitative data and suggested there were several contextual factors that affected their practice. Some of the factors raised by the nurses were education, isolation, fear, support and mentorship, taking ownership, finding autonomy, leadership and intuition. The nurses generally moved across these stages to reach the point where they were able to use clinical intuition. The ability of the nurses to move along the path and the likelihood they may move backwards was influenced by the power relations within the context of their work. A discussion of the nurses' practice as they moved along the path to clinical intuition will now be undertaken to examine some of the major factors and how they may impact nurse decision-making and clinical practice.

8.8 Influences on Clinical Practice

8.8.1 Isolation

One of the themes discussed by the nurses in the interviews was isolation. The nurses associated feelings of isolation with fear and feelings of loneliness. Isolation is related to the context of an institution including the relationships within teams, organisational culture and physical location. When responding to the interview questions, the nurses felt that the context of both professional and geographical isolation had a notable effect on their practice.

Professional isolation has previously been recognised as a reason for difficulty attracting and retaining nurses in rural areas (Conger & Plager, 2008; Hegney et al., 2002). For rural nurses in particular, it is not uncommon to experience a sense of isolation (Conger & Plager, 2008;

Paliadelis et al., 2012; Williams, 2012). Professional isolation contributes to uncertainty and doubt in provision of safe and effective care (Petrie, 2011), competence problems (Williams, 2012), performance appraisal problems, inability to use training and qualifications to the full extent and nurse retention problems (Kidd, Kenny, & Meehan-Andrews, 2012; O'Donnell, Jabareen, & Watt, 2010). In this research, Jess, Cindy and Lauren all discussed feeling professionally isolated while the rural nurses had the additional challenge of being geographically isolated. Feelings of isolation were generally associated with either being a sole clinician in a location, or being the sole clinician with a particular set of skills within a location (such as a senior ICU nurse).

Working as a sole clinician has been linked to feelings of isolation. Conger and Plager (2008) reported that the physical presence of other health professionals increased nurses' feelings of connectedness. The nurses in the study by Conger and Plager (2008) relied on the presence of a mentor to support them with clinical decision-making. The absence of connectedness has previously been recognised in the literature as a threat to rural nurse retention and therefore may be worthy of further exploration, particularly considering the benefits of rural mentorship education shown in the past in Australia (Mills, Lennon, & Francis, 2006). Research that has focused on rural nursing has identified the importance of support and mentorship of these nurses, particularly in the first 12 months of their careers (Hegney et al., 2002). Newhouse (2005) also described the lack of networking as a source of feelings of isolation in rural nurses. Unfortunately, the physical presence of a mentor or health professional is not always accomplishable in rural areas.

Geographically, isolation is inherent in Australia as the country has a large area with a relatively low population density. Due to this, technologies have been introduced into health care to allow rural clinicians and patients to link with those in larger facilities with specialty skills. The issue with technology is that it is innately flawed, with infrastructure and economic requirements not always sustainable in rural areas. The nurses in this study who worked in rural areas pointed out the flaws in the technology they were given. Slow connection capability, delays, outdated technology and hours of operation were serious issues. For example, Cindy discussed that although she was aware that the critical care advisory service was available, there were still delays when attempting to contact them if they were already on the phone or busy. Emily also pointed out using technology to access assistance was not an option all of the time as the critical care advisory service was closed overnight and many emergencies occurred during the time the

service was closed (the critical care advisory service was open 0700–2000 hours at the time this research took place) (MLHD, 2016).

Interestingly, in this study the feelings of isolation were not limited to nurses working in rural settings. The nurses from the large regional hospital also reported feelings of professional isolation at times, particularly in regards to skill mix. Lauren described the effect a largely junior workforce had on the confidence of senior nurses. She stated that the support gained from working alongside experienced nurses was important for her clinical practice. What this infers is that nurses may feel professionally isolated when they do not have others around with a similar skill set to themselves with whom they can discuss clinical practice. This is reflected in the research conducted by O'Donnell et al. (2010) who asked nurses working in large general practices about professional isolation and found that feelings of isolation were related to the number of nurses the participants worked with. They also found that nurses felt professionally isolated when they were unable to use their training and qualifications to their full extent (O'Donnell et al., 2010). Paliadelis et al. (2012) found that skill mix was an issue in regard to professional isolation when staff did not have access to experienced clinical colleagues for advice.

In this study, Cindy, Tilly, Emily and Jess (who worked in rural sites) and Darren and Kat (who worked in the regional site) all discussed that the lack of education when NIV was introduced into their practice was a concern. Isolation and lack of education have a relationship with one another. Nurses who are professionally and/or geographically isolated do not have the ability to participate in educational opportunities to the degree their metropolitan counterparts do. Jess stated that, in her rural facility, staff would be unlikely to attend education that involved travel. Newhouse (2005) similarly reported that maintaining nurse competency in rural areas was a challenge, according to nursing executives. This is a result of having fewer staff and specialists and also less ability to collaborate with universities and other facilities (Newhouse, 2005). Other barriers to education that have been identified in rural facilities are time for travel, cost of overnight accommodation and inability to release staff for educational opportunities (Barrett, Terry, Lê, & Hoang, 2015; Wolf & Delao, 2013). As a result of their inability to participate in education, Cindy, Tilly, Emily and Jess (who all worked rurally) felt they suffered from a lack of exposure to NIV which was something that inhibited their ability to use the treatment. This was described as 'skills rusting' by Kidd et al. (2012, p. 13) and influenced the participants' lack of confidence in their nursing ability. Kidd et al. (2012) described that the

nurses in their study were trained in skills they did not have the opportunity to use due to the variability in their position, and so by the time the skill was required they could not recall their training.

The nurses in this study did not only describe their own lack of knowledge as an issue, but they also felt their medical colleagues suffered from the same concern. Cindy, Tilly and Emily discussed the reliance that the nurses and doctors in rural hospitals had on one another as a result of neither profession having received ongoing education on the use of NIV. The nurses working in the regional facility also described inconsistencies in medical education having a negative effect on their practice. Kat discussed the lack of training provided to junior doctors impacting on treatment decisions. She commented that due to this, there were instances when she had taken over direction of the NIV treatment from the junior doctor and had explained her actions to the intensive care specialist later. Lochlan and Darren both pointed out that among consultants there were inconsistencies in the prescription and use of NIV.

Inconsistencies in practice have been recognised by Wolf and Delao (2013) who interviewed rural nurses regarding their education needs and found that, in addition to their own education, the nurses found the variable skill levels of the physicians they worked with were a challenge. This issue is particularly pertinent in rural areas where doctors may find it difficult to obtain specialist skills. Lewkonia (2001) identified that professional isolation was a significant issue for medical practitioners in both rural and metropolitan areas. He felt that professional isolation for medical practitioners occurred in several categories including physical distance, separation from learning environments and detachment from peers (Lewkonia, 2001). Similar to the suggestions from the nurses, Lewkonia (2001) suggested that doctors should also seek regular personal contact for their learning. He suggested that to address this issue, organisational culture and incentives should be offered to staff to encourage collegial learning behaviour (Lewkonia, 2001, p. 529).

Researchers have recognised that, due to the contextual and resource differences between rural nursing practice and other forms of nursing, rural nursing has been recognised as its own specialty (Fitzgerald, 2008; Medves, Edge, Bisonette, & Stansfield, 2015) and is often described as multi-specialist or generalist practice (Kidd et al., 2012; MacLeod et al., 1998). To ensure that this specialty is developed and maintained, it is essential that education programs tailored to isolated rural environments emerge (MacLeod et al., 1998). Some Australian institutions have designed programs to address this. In one location in Australia, two

universities have collaborated with a rural hospital to establish a rural nursing and midwifery clinical school on-site (Francis et al., 2016). This has preliminarily resulted in increased education provision to the rural nurses along with increased recruitment and retention of nursing and midwifery staff (Francis et al., 2016).

Despite current efforts to increase connectivity through telecommunications and collaborative projects, the results of this research project suggest that isolation still has a notable impact on the practice of nurses. The effects of isolation discussed are not unique to nursing and are present in both the rural and regional hospitals. Interdisciplinary collaboration has previously been suggested as a means of addressing issues of professional isolation and may be one way to address this (Paliadelis et al., 2012). Collaborative activities could include connecting small hospitals to larger ones for regular education and connecting different disciplinary fields locally for the purpose of education and networking. Large education institutions, such as universities, should consider their ability to partner with rural facilities as was successfully accomplished by Francis et al. (2016). These initiatives may decrease feelings of isolation for some health professionals, leading to increased job satisfaction and improved patient outcomes.

8.8.2 Support and Mentorship

The nurses in this project also described support and mentorship as a point on their path to clinical intuition. They felt that one of the most poignant reasons for forward progression in their career was due to other nurses taking time to connect, teach and listen to them. Cindy and Tilly both discussed the importance of their rural EDs having the ability to contact specialty nurses in the regional site for advice and assistance. Tilly stated that without that support she felt lonely. Lauren, from the regional facility, also talked about the importance of other nurses supporting her when she was advocating for her patient. Darren, from the same facility, identified mentorship from other nurses as one of the main reasons he had improved his clinical practice. He described the mentorship he had received as, *'Nurses going above and beyond'*. Both formal and informal mentorship was important to the nurses.

The most widely cited reason for implementing mentorship programs in hospitals is for retention of nursing staff and this has proven to be the case (Burr, Stichler, & Poeltler, 2011; Halfer, 2011; Schroyer, Zellers, & Abraham, 2016). This may be a particularly pertinent consideration for rural nursing in Australia – an area that suffers from poor retention (Mills, Francis, & Bonner, 2005). Organisations may benefit from other outcomes of mentorship

programs such as a more engaged workforce, success in planning needs and professional development of senior and junior staff members (Jakubik, Weese, Eliades, & Huth, 2017). Mentorship programs have also been suggested to be beneficial in bridging the gap between new nurses and older generations of nurses (Nelsey & Brownie, 2012). Mentorship may also address issues of professional isolation, particularly for nurses working in rural areas (Paliadelis et al., 2012). Interestingly, the nurses in this study are not unique in their description of mentorship as being an adjunct to reaching clinical intuition. Stern (1983) described nursing gestalt (linking intuition with clinical knowledge) as a phenomenon that could be passed from a mentor to a novice nurse through nurturing, socialising and teaching. They interviewed 28 critical care nurses to describe the cognitive processes used by experienced nurses and their ability to pass on those skills to more junior nurses (Stern, 1983). The ability of mentorship to assist nurses to move along the path to clinical intuition by empowering them and providing support to their practice therefore makes it an important factor for the profession.

The initial impetus for the inclusion of mentorship in nursing was the description of reality shock by Kramer (1974). Reality shock describes the harsh change from the protected learning environment of a nursing student to the reality of working clinically as a RN (Kramer, 1974). In the present study, several of the nurses discussed their fear when they were first presented with NIV, many as junior nurses. Most notably, Kat described that, three months into her new graduate program, she was asked to look after a patient being treated with NIV, having never used it before. Instances such as this were described as common by the nurses with both Darren and Lochlan saying they had seen such practices occur regularly. Kramer (1974) suggested that mentorship may be one avenue to help alleviate reality shock. Interestingly, Kat described asking senior nurses for education and assistance when she subsequently cared for a patient being treated with NIV. She felt that she was empowered through their assistance.

Contemporary discussion of nurse mentors recognises mentorship as a process in which a more experienced nurse acts as a role model, coach and teacher for a nurse with less experience for the purpose of personal and professional growth (Cohen, 2003; Galbraith & James, 2004; Pataliah, 2002). Mentorship is a complex process that not only incorporates progression of the mentee but also the mentor (Galbraith & James, 2004). The process of mentorship has also been suggested to include the development of metacognitive skills (Collins, Brown, & Holum, 1991). It incorporates personal career development through assistance with career decisions, networking, provision of challenges and recognising strengths and weaknesses (Dracup &

Bryan-Brown, 2004; Race & Skees, 2010). Possibly due to these positive outcomes, mentorship appears to be relatively common in contemporary nursing and many nurses have experience as both a mentor and a mentee (Mariani, 2012). In addition to vertical mentorship programs where a nurse with more experience mentors one with less experience, success has been reported using horizontal mentorship programs where nurses are mentored by their peers (Luck, Chok, & Wilkes, 2017).

The nurses in this study identified the benefits they had received from being mentored by other nurses but the literature also suggests that there are benefits for the mentors such as gaining a sense of value (Race & Skees, 2010). Mentors may also progress in leadership and problem-solving skills (Schroyer et al., 2016). Nurses who have previously mentored described the most important attributes of the relationship as offering feedback on performance, sharing expertise, serving as a role model and demonstrating belief in the protégé (Mariani, 2012). Others have suggested that important traits in mentors include being knowledgeable, flexible, kind and determined, and motivated (Gruber-Page, 2016). Qualities deemed to be important in leaders and mentors include self-knowledge, strategic vision, risk-taking and creativity, interpersonal and communication effectiveness, and inspiration (Dracup & Bryan-Brown, 2004).

Darren was the only nurse in this research who discussed mentorship as a formal process, instead, it was largely experienced by the nurses as an informal adjunct to their clinical practice. This finding replicates that of Mariani (2012) who reported that informal mentorship programs accounted for the majority of mentorship. This may be due to minimal organisational support for mentorship due to perceived lack of time and money to sustain mentorship programs. Despite this, it is well recognised in the literature that organisational support for mentorship programs is essential for their existence (Race & Skees, 2010; Mariani, 2012). Race and Skees (2010) also recognised the importance of an organisation having an understanding of its staff and the culture of the workplace before attempting to implement solutions aimed at career progression and retention of staff such as mentorship programs. They suggested key elements that should be present within an organisation to facilitate a mentorship program include “... stable infrastructure, managerial and executive support, incentives and recognition” (Race & Skees, 2010, p. 166). In the past, organisations have used demographic staff data to design programs that are specifically tailored to their workforce (Johnson, Billingsley, Crichlow, & Ferrell, 2011). Domain-specific data have also been used in the past by organisations to design and deliver education programs to facilitate the mentorship process (Mills et al., 2006).

The word 'mentor' was not used by the rural nurses in this project. Instead, they spoke of reliance or support being provided by nurses at the large regional hospital, commonly, via phone. The absence of explicit mentorship programs at small rural facilities may be due to the limited number of staff employed in the hospitals and the professional isolation that was described by the nurses in these areas (such as having only one or two nurses rostered on a shift). Previous research has demonstrated that, for rural nurses, establishing a relationship with staff from a larger hospital can be beneficial for feelings of connectedness (Conger & Plager, 2008). As with many communications between rural and regional/metropolitan areas, Conger and Plager (2008) found that talking over the phone also decreased their feelings of isolation. Relying on technology to facilitate communication can, however, also present difficulties. In this research, the nurses felt that technology was important, but only as useful as the connection it was able to provide and this was often fraught with delays. This was evident in the remarks made by Cindy and Tilly who pointed out problems with delays in telecommunications and limited opening hours of the local advisory service. The nurses in the study by Conger and Plager (2008, p. 31) made the same remark, commenting that "when telecommunication equipment was functioning, it was invaluable".

The incorporation of mentorship into nursing education and progression makes sense as nursing and medicine have traditionally come from apprenticeship models where a more experienced person taught a less experienced person how to practise (Dracup & Bryan-Brown, 2004). Incorporating mentorship into nursing has many benefits. In addition to the organisational benefits of retention of staff, the support and feelings of connectedness nurses gain from mentorship seem to be important for their happiness in the profession. This may be because of the sharing nature developed through mentorship. Sharing has previously been recognised by Wilkes, Doull, Ng Chok, and Mashingaidze (2017) as a proponent of nurse enjoyment within the profession. Nurses have identified that working in positive team environments has a notable effect on their work enjoyment as they are able to "share with each other unique experiences and provide mutual support to each other" (Morris-Thompson, Shepherd, Plata, & Marks-Maran, 2011, p. 687).

Considering the importance of mentorship and support to nursing, this area is something that should be considered by individual nurses and their organisations as a method to promote the development of staff. Organisations that do not currently coordinate mentorship programs should do so as these programs are relatively cost effective and have a significant impact on

the connectedness and progression of staff. As health professionals, nurses should attempt to identify mentors in their workplace and form a professional relationship that allows for mutual nurturing of skills.

8.8.3 Taking Ownership and Finding Autonomy

Throughout the interviews the nurses discussed moving into a position where they took ownership over their education and the use of NIV and became leaders within their clinical environment. The story that best demonstrates this is the one told by Emily, a nurse from one of the rural hospitals. Emily spoke of being '*really scared*' when NIV was introduced into her practice because she had no education regarding how to use it and was immediately expected to provide the treatment for patients. She outlined how, due to her fear, she took control over her practice and began to teach herself, read widely, and consulted others. Emily moved forward by beginning to teach other nurses in an attempt to alleviate their fear of the machine. At the time of the interview, Emily described being in a position where she could assess a patient, determine NIV was required for their treatment, set the machine up and call the doctor to initiate the treatment plan.

This aptly demonstrates how Emily took ownership over her practice and gained autonomy. Autonomy in clinical nursing has been defined as:

The freedom to act on what you know in the best interests of the patient ... to make independent clinical decisions in the nursing sphere of practice and interdependent decisions in those spheres where nursing overlaps with other disciplines ... It often exceeds standard practice, is facilitated through evidence-based practice, includes being held accountable in a constructive, positive manner, and nurse management support. (Kramer & Schmalenberg, 2008, pp. 60–61).

Manojlovich (2007) described the importance of control over the content and context of nursing practice for the empowerment of nurses. She describes autonomy over these choices as one type of power nurses require (Manojlovich, 2007, p. 4). When they are empowered, nurses are able to exercise their autonomy (Paganini & Bousso, 2015). The power of autonomy is not held by the nurses, *per se*, but is present within the environment in which they work and the relationships they establish within that environment. Environments provide a source of empowerment when they allow clinicians the means to do what they feel is necessary to get their job done (Manojlovich, 2007, p. 4).

Autonomous practice in nursing has been associated with the provision of high quality nursing care, patient safety, and decreased mortality due to an increased sense of engagement and accountability (Keith & Cianelli, 2014). Critical care nursing in particular requires a level of autonomy as patients who are critically unwell consistently require problem solving and critical thinking (Paganini & Bouso, 2015). Due to this, critical care nurses have rated professional autonomy as being very important to them (Karanikola et al., 2014; Paganini & Bouso, 2015). As reported by Kramer and Schmalenberg (2008, p. 64), the most frequently cited reasons for nurses exercising autonomy were emergencies, need to rescue, patient advocacy, triage, end of life care, and coordination. The use of NIV encompasses many of these domains. Professional autonomy is also related to job satisfaction for nurses (Iliopoulou & While, 2010). Despite this, critical care nurses have described their level of autonomy as moderate, with rare instances of independent clinical decisions (Bertolini et al., 2010; Karanikola et al., 2014; Papathanassoglou et al., 2005; Villa, Manara, & Palese, 2012). This was similarly reported in a study of magnet hospitals, where autonomy in ICUs was only scored highly in eight of the 34 units studied (Kramer & Schmalenberg, 2008).

In the current study, there was evidence that the nurses were unsure about their scope of autonomy and what it actually meant in their workplace. This was evidenced by the discrepancies in who the nurses described as decision-makers and whether they felt they could initiate clinical care. Cindy and Caitlin both felt that, although they could make suggestions, decision-making was solely the responsibility of the doctor, and, as stated by Cindy, *'He has influence, full stop'*. Conversely, nurses such as Lauren, Darren and Kat discussed taking over decision-making capacity, particularly if they felt it was in the best interest of their patient. Kat stated, *'If things all went to hell in a hand basket, I would change it [the treatment plan] ... and live with the consequences if the patient needed that'*.

It was also evident that the nurses did not feel they were supported to practise autonomously by the organisation or their colleagues, particularly by their medical co-workers. When some of the nurses attempted to voice concerns, or discuss changing treatment, they were dismissed by their medical colleagues. This was described by Lochlan when he spoke of attempting to escalate his patient's treatment. He had identified that the patient, who was being treated with NIV, was deteriorating and recommended the patient be intubated. His concerns were dismissed by the intensive care specialist who went home, only to be called back when the patient's condition had deteriorated significantly.

The effect of the organisational structure of hospitals on nursing autonomy warrants attention. Kramer and Schmalenberg (2008) identified that, although nurses seek autonomy, they reported they receive little support in doing so. Previous research has shown the positive effect that organisational support of autonomy has on nurse satisfaction and retention (Kramer & Schmalenberg, 2008). Conversely, research conducted in Iran identified several profession-related factors that affected the ability of nurses to practise autonomously. These factors included a “lack of strong professional bodies, organizational barriers [including] role ambiguity, a directive rather than supportive workplace and lack of motivation” (AllahBakhshian et al., 2017, p. 394). It must be considered that autonomy is not inherently present in nursing due to the traditional boundaries of the profession enforced by the medical profession, the lack of institutional support and economic, political, social and cultural barriers (AllahBakhshian et al., 2017; Baykara & Şahinoğlu, 2014). The presence of junior doctors and intensivists in ICUs at all times also affects nursing autonomy through increased overlap of roles (Kramer & Schmalenberg, 2008).

The deterrents for the development of nursing autonomy that were reported by AllahBakhshian et al. (2017), Baykara and Şahinoğlu (2014) and Kramer and Schmalenberg (2008) may have had an influence on the nurses in this study. It was evident that, despite the benefits associated with nursing autonomy, not all of the nurses reached this position in their practice. Caitlin had been working as an intensive care nurse for more than 12 years yet she described feeling uncomfortable when caring for patients on NIV who were agitated. She also discussed the use of NIV as a treatment that was prescribed by the doctor, adjusted by the doctor, and weaned by the doctor, and did not mention herself having an autonomous position within the treatment. It has previously been identified that nurses always have the ability to change their position in practice regardless of the empowering or disempowering context of their organisation, but not all take the opportunity to change (Manojlovich, 2007, p. 8).

Some nurses described frustration at their circumstances but were unable to move into a position of empowerment to practise autonomy. Tilly described a disconnect that sometimes occurred in the ED as a result of the nurses and doctors having different priorities and the hindrance this caused in patient treatment. The effect of the nurse-doctor relationship on clinical practice is a phenomenon deeply embedded in the professions and influenced by societal, institutional and cultural constraints (McHale & Tingle, 2007). It is, however, a slowly changing process, described by some as an evolution rather than a revolution (Blue &

FitzGerald, 2002, p. 321). In the meantime, nurse-doctor relationships should be recognised not as fixed entities but as fluid relations that are influenced by context and experience (Pullon, 2008). Collaboration may be important in achieving progress for both professions. Means by which collaboration can be achieved between doctors and nurses have been suggested to include formal collaboration, shared mental models, team coordination and communication (Weller, Barrow, & Gasquoine, 2011). Shared mental models refer to the idea that “Team performance improves if team members have a shared understanding of the task that is to be performed and of the involved teamwork” (Jonker, van Riemsdijk, & Vermeulen, 2011, p. 1).

The importance of autonomy to nurses and the effect professional autonomy has on their practice make it worthy of consideration at the individual, professional and organisational levels. Methods to increase autonomy in nursing have been suggested to include defining autonomy and the unique and overlapping spheres present in the profession of nursing, periodic renegotiation of the scope of nursing practice and administrative support (Kramer & Schmalenberg, 2008). The areas suggested by Kramer and Schmalenberg (2008) to improve the ability to practise autonomously are applicable to the area in which this research was conducted.

8.8.4 Reaching Clinical Intuition

In this study, Cindy, Lochlan, Emily, Lauren, Kat and Darren all described arriving at a point of clinical intuition as a result of their journey to acquire education, support and mentorship, ownership and leadership. It seems that intuition has been present in nursing almost from the time of the profession’s conception (Rew & Barrow, 1989). It was, however, rarely discussed and often not referred to until the 1980s – probably due to nursing being moulded by the medical profession’s logic and science (Rew, 1988; Rew & Barrow, 1989). Intuition is an understanding without logic that has been described as “knowing without knowing how” (Pearson, 2013, p. 213) or as Benner and Tanner (1987, p. 23) defined it “understanding without a rationale”.

Intuitive practice was often described by the nurses. For example, Emily described how the nurses would get the NIV machine out and set it up when, *‘they could see we were going down that pathway’* – that is, they could see the patient needed NIV and were so confident in this decision that they would immediately retrieve the machine and prepare for treatment, before contacting the doctor. In his description of patient assessment, Darren described assessing his

patient first by looking at them from across the room and building a *'clinical picture'*. He described trusting his clinical judgement, more so than technology or numbers. Kat defined her patient assessment in a similar way. She stated that she knew if a patient was getting better or worse by looking at them. She would ask herself, *'What's their work of breathing like, what's their colour, are they exhausted?'*

Whether intuition is innate or mystic has been the subject of inquiry (Effken, 2007; Green, 2012; Lyneham, Parkinson, & Denholm, 2008). The nurses interviewed in this research often described using intuition (feeling something needed to be done but not basing that feeling on objective data) but did not describe such practice as 'intuitive' or 'expert'. In fact, many of the nurses described themselves as not being experts, but relying on others who were. Lyneham et al. (2008) explained that nurses could transition to an expert phase of practice without the cognitive awareness that they had done so. According to their analysis of the expert described by Benner (1984), a nurse may not be consciously aware of having the status of an expert because it has become a part of their being (Lyneham et al., 2008, p. 381).

Despite the growing body of evidence that supports the presence of intuition in nursing practice, it remains a contentious component of nursing practice – probably as a result of the difficulty in objectifying intuition. Intuition in nursing has been linked to enhanced clinical judgement, effective decision making, and crisis aversion (Cioffi, 2000; McCloughen, O'Brien, & Jackson, 2010). In this research, the intuition described by the nurses was when they acted not upon empirical evidence, but on information they obtained subconsciously from a combination of their current feelings and their past experience. The nurses described instances where they did not rely solely on their intuition but incorporated objective clinical data into their decision-making. Darren described using patients' observations as a secondary method of data collection after his subjective patient assessment. He felt that this gave him a method of corroborating his findings. Kat also described the use of arterial blood gases and oxygen saturations as a complementary method to her patient assessment. Hassani, Abdi, Jalali, and Salari (2016) found that nurses who used intuition felt that scientific knowledge was essential for receiving intuitive information as it allowed confirmation of their intuitive voices. This was also found by Melin-Johansson, Palmqvist, and Rönnberg (2017) when they examined the use of intuition in nursing practice and demonstrated that nurses may not be able to impact treatment decisions based solely on intuitive findings.

The use of intuition was most evident in this study when the nurses were conducting assessments. They found it difficult to describe how they came to the conclusion that a patient was deteriorating. Darren, Kat, Cindy, Tilly, Lochlan and Emily stated that they would look at the patient. This implies that they could recognise the observational data associated with respiratory distress. But there is a secondary layer to their assessment. The nurses could also identify when a patient was deteriorating even when signs of respiratory distress were not present. This was identified by Lochlan when he described knowing the difference between a lack of respiratory distress due to wellness and a lack of respiratory distress due to exhaustion. He stated there was a '*subtle difference*' between the two.

The nurses also described scenarios in which they knew something was wrong but found it difficult to convey this to physicians because there was no empirical evidence to support their concern. Lochlan described telling a physician that a patient was deteriorating on NIV but the physician disregarded his concern and went home. In the middle of the night the physician was called back to the hospital as the patient's condition had deteriorated significantly. This scenario demonstrates two things. Firstly, the inherent inability of intuition to be based upon objective data poses difficulty in the ability of the nurses to act upon their intuition. In the case described by Lochlan, despite his identification of the deterioration of his patient, he was still unable to act upon his findings because the physician did not have objective evidence on which to act. Secondly, the scenario reiterates the existence of intuition as a phenomenon that exists outside of objectivity as the physician and nurse found no objective reason to believe the patient was deteriorating.

The scenario described by Lochlan corroborates an example from previous research in which nurses had worried that a patient would deteriorate or die despite having normal clinical measurements (Hassani, Abdi, & Jalali, 2016; Hassani et al., 2016). Benner and Tanner (1987) also described a situation in which the nurse felt a patient was clinically deteriorating but did not explicitly say this to the doctor because there was no concrete evidence. Other nurses, such as Kat, discussed a situation in which she had known a patient was deteriorating and initiated NIV treatment before calling the physician and telling him she had done so – he was grateful for her initiative.

Ironically, the nursing profession has traditionally been viewed as intuitive which has led to nursing knowledge being perceived as emotional and feminine compared to the male-

dominated field of medicine which has traditionally been represented as empirical and rational (Buckingham & Adams, 2000; Melin-Johansson et al., 2017). Now, at a time when intuition is recognised as an important component of clinical decision-making, nurses still struggle to use their intuition to impact treatment decisions.

The nurses in this study also indirectly linked exposure to their development of intuition. They were asked what had changed between the time they felt isolated, fearful and clinically incompetent with NIV compared to the point when they were competent and intuitive in their practice (for those who did reach this point). In addition to education, Tilly, Lauren, Darren, Kat, Emily and Lochlan identified experience and exposure as the two main reasons for their progression. Melin-Johansson et al. (2017) found in their literature review of the characteristics of nurse intuition that experience was associated with an increased sense of intuition. The same literature review also found that novice nurses did not act upon intuitive feelings because of inexperience, and experienced nurses did not believe that nurses with less than one year of experience used clinical intuition (Melin-Johansson et al., 2017). The relationship between intuitive practice and years of experience has previously been discussed in the literature (Pretz & Folse, 2011). This relationship makes sense if intuition is considered as the re-emergence of past experiences that have been stored in the mind. There is also some conjecture that the experience required for intuition may be life experience rather than nursing experience only (Ruth-Sahd & Tisdell, 2007). This cannot be commented on, based on the findings of the current study, as the nurses were not asked about intuitive practice in others and all of the nurses interviewed had greater than three years' experience as a RN.

If experience is not the only factor responsible for the acquisition of intuition then it is important to examine what else may contribute to this phenomenon. McCutcheon and Pincombe (2001) examined the multifactorial nature of intuition and found intuition was a result of the synergy between knowledge, experience and expertise, and was influenced by personality, environment, willingness for its use, and the relationship with the patient. Benner and Tanner (1987) also proposed that intuition developed from a synergy of pattern recognition, similarity recognition, common sense understanding, skilled know-how, sense of salience, and deliberate rationality. Another argument for the multifactorial nature of intuition is that it does not develop in all nurses (Green, 2012), regardless of their years of experience. This was true in the present study where not all nurses described intuitive practice. Green (2012) also stated that not all nurses progress to a point in their practice where they are able to use intuition.

The development of intuition in nursing is an important area for future research so that this skill can be further understood and possibly enhanced. Intuition is particularly important in nursing because it assists nurses to make decisions in a way that flow-charts and checklists cannot (Benner & Tanner, 1987). Suggestions for further investigation of intuition have been made previously and should be further explored (Smith, 2009). Part of this investigation may include looking at whether nurses who are generally intuitive are more intuitive in their practice or if intuitive people are more likely to become nurses.

The findings from this research indicate that intuition is an important part of nursing. The use of intuition incorporates the integration of all other essential components of nursing such as education, support and mentorship, and autonomy, but also adds an extra existential layer to these attributes. None of the nurses in this study described their intuition as being incorrect or leading to adverse patient outcomes when they acted upon it. Adverse outcomes did, however, occur when the nurses were unable to follow their intuition due to physician disagreement. This was also found by Rew and Barrow (1989) who described that nurses were frustrated by their inability to convey their concerns based on intuition. If they failed to do so, or did not act on their intuition, poor care resulted (Rew & Barrow, 1989). This further emphasises the importance of nursing as a profession gaining an understanding of intuition and how it is used in practice.

The nurses in this study who did use intuition used it to assist their clinical assessments and guide treatment plans. Despite the progression of Cindy, Lochlan, Emily, Lauren, Kat and Darren to a position of clinical intuition, Caitlin, Jess and Tilly did not discuss their practice with reference to intuition or through a description of actions that may have been classed as intuitive. The ability of some of the nurses to progress to a position of clinical intuition and the inability of others to do so were a result of the contexts in which they worked and the intricacies of their relations with their organisation, colleagues and education. The power relations present within their contexts were discussed by several of the nurses and will now be explored to provide insight into the reasons why some of the nurses reached a point of clinical intuition and others did not.

8.9 The Effect of Power Relations on the Path to Clinical Intuition

This research has examined the use of NIV as a treatment for acute exacerbations of asthma and determined that there is a wide variation in the likelihood patients will receive this treatment. Nurses were interviewed in this project to provide an explanation of the specific contextual effects they felt were present in their practice. What they identified was that the ability to use NIV is dependent on education, isolation, fear, support and mentorship, taking ownership, leadership and intuition. The progression to the point where the nurses are able to use intuition in their practice has been labelled in this research as the path to clinical intuition. It should be noted that, despite several of the nurses reaching the point of intuitive practice, Caitlin, Jess and Tilly did not discuss intuition at all. The ability to move backwards along the path to intuition was also described by Darren who had felt he was clinically comfortable and competent using NIV until he had an experience in which one of his patients deteriorated. It is evident that there were several effects on the nurses' practice and these influences impacted on whether the nurses progressed towards intuition, remained stagnant, or moved backwards.

In relation to the themes identified that incorporate the path to clinical intuition, there were three prominent power relations present: power and knowledge, power in collegial relationships, and power and the institution. An understanding of these relations is essential to an understanding of the ability of the nurses to progress towards clinical intuition. Discussion of the movement of power and its relationship to the path to clinical intuition will now be undertaken with reference to the work of Michel Foucault. The major foundations of his theory on power were that power is not a possession, power is resisted, and power can be made sense of through knowledge. These concepts were present within the stories told by the nurses and will now be discussed in relation to the findings of this project.

8.9.1 Power and Knowledge

One of the hallmarks of Foucault's discussion of power is the relationship he describes between power and knowledge. Foucault (1995, p. 27) stated:

Power produces knowledge ... power and knowledge directly imply one another ... there is no power relation without the correlative constitution of a field of knowledge, nor any knowledge that does not presuppose and constitute at the same time power relations.

The lack of knowledge, isolation and fear described by the nurses in this research when they were first introduced to NIV are inherently related to the power relationships present in the

context of their work. The acquisition of knowledge, or lack thereof, had direct implications on the ability of the nurses to use NIV. Lack of education regarding the use of NIV translated to nurses feeling uncomfortable using the treatment and being less likely to do so. This brings into focus the power of knowledge in health care and, consequently, the disempowerment of those from whom knowledge is withheld.

Knowledge needs power to exist, a complex relationship that Foucault (1980) terms 'power/knowledge'. He draws attention to the relationship between power and knowledge and their reliance on one another by stating "It is not possible for power to be exercised without knowledge, it is impossible for knowledge not to engender power" (Foucault, 1980, p. 52). The nurses in this project needed knowledge in order to take control over their clinical practice and their professional persona. From the place in which they felt isolated and afraid, to the position of power they held as intuitive practitioners, one of the most significant changes that occurred was their acquisition of knowledge. Resistance of the nurses against the position in which they felt they lacked knowledge was the impetus for change. The nurses did not accept their position but resisted it until they moved to a position of knowledge.

The impetus for change for several of the nurses was when they discovered they did not have the knowledge they required to care for their patients safely. Kat labelled this a, '*Trial by fire*' when she discussed the scenario in which she was allocated a patient being treated with NIV, but had no experience with the treatment. She described being, '*Completely out of my depth*'. After this occurrence, Kat sought education so that she would not be in the same position in the future. Darren had a similar first experience with NIV in which he was told to care for a patient on the treatment, having never done so before. He was motivated to change so that he would never be put in a similar situation. Darren stated, '*Knowing what I know now, there's no way in hell I'd do that ever again*'. Lochlan also described his first use of NIV as being, '*... thrown in the deep end*' as he was required to use NIV before he had been trained to do so. For Kat, Darren and Lochlan these experiences caused them to resist their initial positions and become motivated to seek knowledge. This enabled them to move from a position of powerlessness to a position where they were informed and empowered.

Foucault believed that power was not essentially repressive, but always required resistance (1980, p. 142). Power produces resistance firstly because the practices of power have no claim to universality therefore there is always the existence of a contingency. Secondly, because power "works across technologies, individuals and institutions it produces a multitude of

categories and subcategories of people and forms of behaviour, which compete with one another to regulate and control populations” (Schirato, Danaher, & Webb, 2012, p. 49). The formation of these categories naturally leads to a formation of mutually incompatible categories that act as a type of resistance (Schirato et al., 2012, p. 49). Foucault 2003, p. 179) stated the resistance to power was:

... an immense and multiple battle, but not one between knowledge and ignorance, but an immense and multiple battle between knowledges in the plural—knowledges that are in conflict because of their very morphology, because they are in the possession of enemies, and because they have intrinsic power-effects.

Another example of resistance was present in the interview with Tilly. She explained that when NIV was introduced into her facility neither she, nor the other nurses had been given education on how to use it as a treatment. Tilly resisted this position on her own behalf and that of the other nurses. She stated, *[I] started that push of ringing and asking, and harassing people*’ to provide the nurses in her facility with education. Tilly was not resisting the organisation or the NIV machine, but rather she was resisting the lack of education felt by both herself and her staff.

The actions of Tilly, Kat, Darren and Lochlan were not working against an individual or an institution, but a type of power that was exerted against them within the context of their clinical work. This would be classified by Foucault as a type of ‘local’ or ‘immediate’ struggle (Mills, 2003, p. 38). “The main objective of these struggles is to attack not so much ‘such or such’ an institution of power, or group, or elite, or class, but rather a technique, a form of power” (Foucault, 1982, p. 781). The result of resistance to power is both disruptive and productive. The disruption is mainly due to the competition for regulation and control (Schirato et al., 2012, p. 63). The productiveness that results from power occurs “in the sense that it shapes and moulds people, their dispositions and values, and their practices” (Schirato et al., 2012, p. 46). Because power is both disruptive and productive it brings about events.

In the context of this research, the disempowerment felt by the nurses when they lacked knowledge caused events such as them taking control over their own education, seeking help, teaching each other, and, for some, moving to intuition. Tilly and Emily described working in a facility where education on NIV was not offered to them, so they travelled to a larger facility to attend a seminar and went back to their rural area to share their newly acquired knowledge with their co-workers. This is an example of empowerment and can be understood in reference

to Foucault's description of power as an abstract force rather than something developed by individuals (Mills, 2003, p. 70).

We should admit rather that power produces knowledge (and not simply by encouraging it because it serves power or by applying it because it is useful); that power and knowledge directly imply one another; that there is no power relation without the correlative constitution of a field of knowledge, nor any knowledge that does not presuppose and constitute at the same time power relations (Foucault, 1995, p. 27).

All the nurses in this project described resistance through one or multiple means including learning, educating, support and mentorship, ownership, leadership and intuition. Many of them described their position as both a learner and an educator at various points within their clinical practice. Cindy pointed out that, *'Even when you have a clinical nurse educator on hand they're not the expert at everything'*, so her role as the educator did not always mean that she was educating, sometimes she was learning. Tilly also discussed how, due to her discomfort with NIV and lack of training, she travelled to a larger site and attended an NIV course, then returned to her facility and provided her co-workers with education. When the context changed and the facility employed a staff member with extensive critical care experience, she again became a learner and participated in education on the use of NIV from someone with more extensive knowledge.

Darren was passionate about the need to educate others. He stated that he made an effort to mentor and support people appropriately. He explained that because of his negative first experience with NIV, he would never, *'... leave someone [a patient] that critically unwell with ... [a nurse who had] ... limited knowledge of NIV'*. Despite this view and his efforts to educate others, Darren described the importance he attributed to the education he had received from other nurses.

The ability of Cindy, Tilly and Darren to teach and learn from others was influenced by their context. They would teach when they recognised that within their current context they had knowledge that others did not have, and conversely, they would learn when they were in situations where others had knowledge that they did not have. This shows that power moved in relation to context. A patient's presentation, presence of different colleagues, time of day and resources all had an effect on the role the nurses would take, whether it be as an educator or a learner. Cindy, Kat, Lochlan and Lauren had previously worked, or were currently working, as nurse educators. Regardless of position title, the nurses expected to be taught or to

teach according to their context, as an inherent characteristic of their profession. This symbolises the fluidity of nurses as learners and educators and is demonstrated by Figure 8.1 which shows a nurse can move from being a learner to an educator and vice versa.

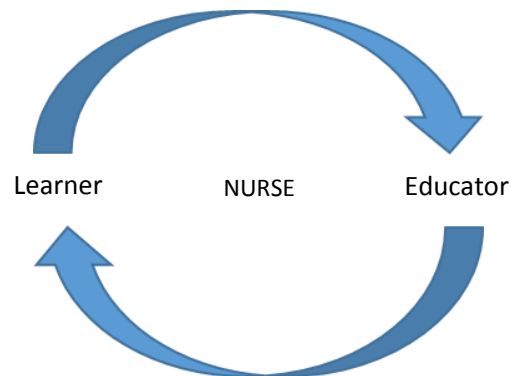


Figure 8.1 The fluidity of a nurse as both a learner and educator

In this instance, the educator is not a nurse educator but is any nurse who has and shares knowledge, at the time they are giving that knowledge, whether that be to other nurses, patients or healthcare professionals. Similarly, the learner refers to any nurse who is receiving knowledge at any point. This allows a co-acquisition of knowledge between all individual nurses as both learners and educators according to the boundaries set by the system. Although the nurses in this project were empowered by their ability to educate and learn from one another, the fluidity of these positions was bound by the institution in which they worked. For example, even though some of the nurses expressed that they would like to attend certain education, they could only do so within their institutional confines. Caitlin described how, even if she wanted education on a new piece of equipment, education that was provided was limited and she was often not able to attend because she would be required for patient care and not released for education. Jess also described that when the NIV machine was delivered to her facility the nurses were not provided with any education. Instead, two staff members were sent to a training day and when they returned they were expected to train the others. Cindy also described how, even within her position as a clinical nurse educator, she was not given training on the use of the NIV machine so relied upon other nurses to teach her how to use it. Considering these examples, Figure 8.2 more adequately defines that while a nurse can be both a learner and an educator, this can only occur within the context of the institution in which they are practising.

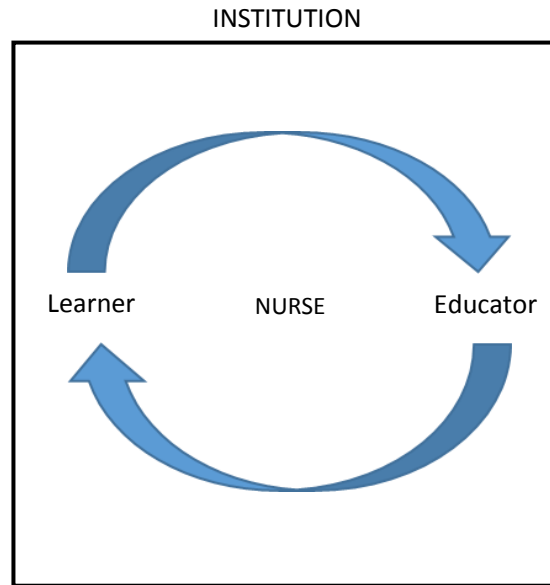


Figure 8.2 The fluidity of a nurse as a learner and educator is bound by the context of the institution

The importance of context in the acquisition of knowledge necessitates a review of healthcare institutions as a boundary for power relationships. Foucault felt that power was not a possession, but rather a relation (Schirato et al., 2012). Within healthcare institutions, power relations are bound by societal, professional, economic and individual relationships. Power in collegial relationships is one component of this and will be examined next.

8.9.2 Power in Collegial Relationships

The presence of power in collegial relationships had a significant effect on the ability of the nurses to practise in this project. This was particularly pertinent in the power relationships between nurses and doctors. Foucault (1978) discussed power not as a noun, or something that was materially held by one person, but as a verb that was enacted upon by individuals and present within relations. He described the disciplinary power held by the medical profession and the effect this had on the development of health, hospitals and other professions. Disciplinary power was present in the stories told by the nurses in this research.

Lochlan described a situation in which he felt his patient was deteriorating. He stated, *'I think he [the doctor] sort of underestimated how sick she was, and I tried to communicate that with him before he left and he just wasn't that fussed'*. Lochlan's concerns were dismissed by the doctor, but later the patient deteriorated. In this scenario, disciplinary power was exerted by the doctor in his dismissal of Lochlan's concerns. Cindy also described how clinical decision-

making remained unique to the position of the doctors. She stated, *'He has influence, full stop ... [and] ...we [the nurses] can just put in our input'*.

In her discussion of the nurse-doctor relationship, Kat described the response nurses got when they made autonomous decisions. She said, *'We have a particular consultant who doesn't appreciate that, and so, I am more cautious when he's on'*. She went on to describe how the nurses had to forward plan the way they would treat complications that arose, so the doctor could agree to them before they occurred. Kat had found that this was the only way she could balance her patients' needs with her collegial relationship.

The power within the collegial interactions experienced by Lochlan, Cindy and Kat demonstrates the existence of an unequal relationship. The work of Foucault shows that this is probably residual to the traditional relationship between the doctor and nurse, in which knowledge was deemed unique to the medical profession (Foucault, 2003). Throughout the eighteenth century, medicine internally organised all knowledge into disciplines which allowed it to eradicate false knowledge or non-knowledge (Foucault, 2003, p. 181). Lochlan and Kat had experienced the outcome of this, that knowledge outside of the medical profession was dismissed.

Although Lochlan, Cindy and Kat described unequal collegial relationships, several of the nurses told stories of collaboration or nurse leadership. Darren described how, despite the prescription of NIV being a responsibility of the doctors, *'... nurses will often suggest to the medical team to use NIV and are able to clearly define and give the reasons why'*. Lauren also discussed how the nurses' knowledge should be respected by the doctors, and particularly for junior doctors, it should be recognised that the nurses have, *'... a wealth of experience so just trust us if you [the doctor] haven't, if you don't know'*. Kat reported the importance of nurses questioning doctors if they felt they were not making appropriate treatment decisions for the patient. When asked if she was comfortable questioning doctors she replied, *'I think it's our obligation'*. She spoke of questioning and directing doctors politely, and using clinical information to explain her decisions. This has been reported previously by Blue and FitzGerald (2002, p. 319) who stated that nurses felt they could question doctors who were acting inappropriately if they were sure of the facts and could convey them confidently. This corroborates an earlier description by Stein, Watts, and Howell (1990, p. 548) that, increasingly "nurses feel free to confront and even challenge physicians on issues of patient care and even make decisions about patients without first consulting the attending physicians". Conversely,

other researchers have found that clinical decision-making remains firmly in the control of the medical profession (Coombs & Ersser, 2004). This research project suggests that although this was the case in some scenarios, there were several examples of nurses making clinical decisions.

Jess and Emily described the importance of collaboration between doctors and nurses in rural facilities. Jess explained that, in her rural facility, the doctors and nurses worked together when treating a patient with NIV, because the doctors, '*... are as familiar with the thing [NIV] as what we [the nurses] are, so we just work together*'. She also stated that when a patient was admitted to the ED, the decision to use NIV was, '*... generally a group discussion amongst us [the nurses and doctor] but yeah, nurses generally push for it*'. Emily, also from a rural site, said that when patients require treatment with NIV:

It's sort of a team thing. A couple of the doctors – you'll be talking with them, saying "Well, shall we do this? Should we do that?" and so, you sort of all work together because I think it's still, not the unknown, but we're still all in early days. (Emily)

Blue and FitzGerald (2002) found that rurality largely promoted relationships of trust and equality among the nurses and doctors in these settings because they had no other option other than to rely on each other. This was similarly identified by Jess and Emily who spoke of the necessity of nurses and doctors in rural facilities to work collaboratively.

Levels of collaboration have also been shown to be affected by hospital size with higher acuity ICUs reporting lower collaboration levels compared to lower acuity ICUs (Georgiou, Papathanassoglou, & Pavlakis, 2017). In this research, Lochlan, Lauren, Caitlin, Kat and Darren all worked in a regional ICU. The information provided by Lauren, Kat and Darren suggests that within their ICU, working in close proximity with the doctors allowed them to collaborate. Other studies have reported the importance of time spent together to develop a collaborative relationship based on trust (Georgiou et al., 2017). The close proximity of the nurses in this study to their medical colleagues may, for some, have influenced their ability to form a collaborative relationship.

There is no shortage of reasons to promote professional collaboration between nurses and doctors. Research has found that fostering these relationships allows for mutual understanding and respect between the professions and improved patient and healthcare outcomes (Zwarenstein & Reeves, 2002, 2006). This research has demonstrated that although

disciplinary power does exist between doctors and nurses, there are several examples in which they were able to have collaborative relationships. Factors such as the close proximity of the nurses and doctors in rural and regional areas should be investigated in the future to determine avenues for collaboration.

8.9.3 Power and the Institution

The most important notion in the examination of institutional power in reference to the work of Foucault is his belief that power is not something one can possess. In *Psychiatric Power*, Foucault (2006, p. 4) commented:

Power is never something that someone possesses, any more than it is something that emanates from someone. Power does not belong to someone or even to a group; there is only power because there is dispersion, relays, networks, reciprocal supports, differences of potential, discrepancies, etc.

It is in this system of differences which have to be analysed, that power can begin to function (Foucault, 2006). Instead of being an object one can behold, Foucault felt that “power functioned in terms of the relations between and trajectories across and involving people, institutions, bureaucracies and various cultural fields within the state” (Schirato et al., 2012, p. 46).

Foucault’s discussion of intentionality and will in institutions gives insight into the reason behind the power relationship between the hospitals and the nurses. It seems contradictory that institutions have mission statements that often reflect their wishes to protect and advocate for their staff when in practice their staff feel isolated and afraid, as was described by the nurses in this study. Emily stated that, when NIV was introduced into her facility, the nurses were given no explanation or training, but were expected to use it in practice. She described the nursing staff as ‘*scared*’ of the machine, they even ‘*asked if it could be taken*’ but were told ‘*no*’. This example shows the ability of the institution to exert power over its employees. The hospital was able to direct the nurses to use a piece of equipment, despite their fear and concerns.

Mills (2003, p. 50) points out that attributing thoughts and notions to complex institutional bodies is reductionist. Hospitals are complex social structures and the oppression of staff may manifest not due to a direct consequence of the operation of the institution, but as an indirect consequence of the elaborate workings that occur within that structure. When examining the

indirect consequences of its operation, the constraints of government, policies, finance and society must be taken into account. Managers may exist within hospitals and influence their workings and policy, but they can only do so within their own constraints (Mills, 2003, p. 50). Identifying and describing the effects of an institution are thus simple tasks compared to determining the contingencies that create those effects.

Foucault believed that phenomena could never be explained simplistically because everything occurred due to the interaction and occurrence of a multiplicity of events. Foucault (1991, p. 71) terms this 'eventualisation', meaning:

... discovering the connections, encounters, supports, blockages, plays of forces, strategies and so on which at a given moment establish what counts as being self-evident, universal and necessary. In this sense, one is indeed effecting a sort of multiplication or pluralisation of causes.

If, as Foucault (1991) suggests, the occurrence of events is due to a multiplicity of factors, then it would be unwise to attempt to explicitly define the reasons for an event occurring within the context of one organisation. The results of this research project demonstrated that although staff education was a major factor in the likelihood patients would receive NIV, there were several other significant issues such as staffing, resources and experiences that intertwined to affect treatment decisions. Generalisations cannot be made in regards to these data because each institution will have an individual set of factors that influences their own practice. Foucault agrees that generalisations should not be proclaimed, but rather descriptions of events and possible contributions be made and that which is not said is not discounted as a possible part of the relationship (Mills, 2003, p. 116).

As a result, what will be proclaimed here is that the institutions in which the nurses worked individually embodied power as a result of the organisational constraints, positioning of power and interdisciplinary relations that occurred within them. What can be deduced is not the means by which the power exists, but methods by which an institution can harness power to promote the professional development of staff. Methods by which this can occur that have been suggested by this research are the establishment of mentorship programs involving staff as stakeholders in their own education, establishing professional relationships among institutions and encouraging interdisciplinary collaboration.

Examining the power relations of knowledge, colleagues and the institution has given examples of how and why the nurses moved along the path to clinical intuition. It was shown that while

Cindy, Lochlan, Emily, Lauren, Kat and Darren progressed their use of NIV to a position where they were intuitive, Caitlin, Jess and Tilly did not. Intricate differences in the nurses' context have been shown to have had an effect on the movement of the nurses. The place of the path to clinical intuition within nursing as a profession will now be discussed in relation to the current context of nursing knowledge.

8.10 Where Does the Path to Clinical Intuition Fit Within Nursing?

This project has described a path to clinical intuition using the themes provided by the nurses interviewed. The description and discussion of these themes have allowed for examination of why they may exist and how they affect nursing practice. The path to clinical intuition should also be examined in relation to where it may be relevant to the profession of nursing and what information it may add to the understanding of clinical practice. Throughout this chapter, the examination of the path to clinical intuition has shown that the trajectory of the nurses was influenced by their context including the presence of power within their relationships with each other, the doctors and the institution in which they were employed. Movement along the path was described by the nurses as they worked towards being intuitive practitioners when working with NIV. The application of this information to clinical practice more broadly may provide an understanding of the influence of context on clinical practice and the ability of nurses to reach a position of clinical intuition.

Interestingly, in Benner's (1984) discussion of skill acquisition, the highest tier is the ability to work as an expert. In her description of expert practice, Benner related being an expert nurse intimately with the ability to use clinical intuition. She stated "The expert nurse, with an enormous background of experience, now has an intuitive grasp of each situation ..." (Benner, 1984, p. 32). The path to clinical intuition leads to intuitive practice and the novice to expert model ends with the nurse becoming an expert, but as has just been discussed, these points in practice are mutually inclusive. To become an expert is to use intuition and those who use intuition are able to practise as experts. This shows that while Benner's (1984) model of novice to expert is able to explain stages of skill acquisition, the path to clinical intuition shows the effect of changing context on nurses' ability to practise. The models describe different aspects required to reach the same place in clinical practice, as shown in Figure 8.3.

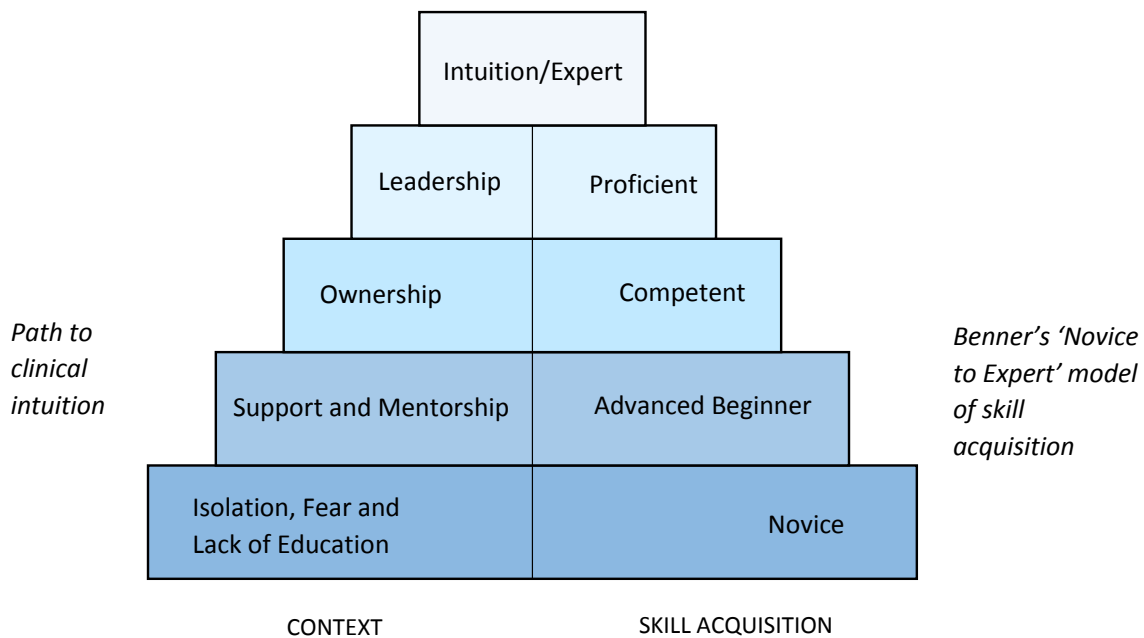


Figure 8.3 The relationship between skill acquisition and context on a nurse's journey to intuitive, expert clinical practice

It is important to note that despite the tiered progression required to reach the point of intuition/expert, movement along the tiers is not linear. As is true of the novice to expert, the path to clinical intuition is situational. This means that in any given situation a nurse may occupy a different position on the pyramid, positions are not stagnant. Nurses may move forwards and backwards fluidly through each of the stages according to the situation they are faced with. In Rew and Barrow's (1989) discussion on nursing intuition they described intuition as a non-linear behaviour, something that does not arise from a stepwise progression. This research supports that statement. The nurses moved towards intuition on a path, but they were able to move backwards or remain stagnant at any point along the way. The fluidity of movement along the path is also heavily influenced by context and power. The nurses described the effect situations had on their movement. For example, Lauren told of being able to practise autonomy and intuition in her former employment in a large metropolitan hospital because it was culturally accepted that it was the role of nurses to do so and they were supported with education to propel them towards intuitive, autonomous practice. Benner (1984, p. 179) also described the novice to expert model of skill acquisition as a non-linear process affected by the current situation. As a result of nurses' ability to be in any one of the stages according to the clinical context, Benner (1984, p. 179) recognised that nurses could not be certified as being novice, competent or expert for all situations.

Research that has examined intuitive practice in nursing has shown examples of the impact of this practice on patient outcomes. Nurses who practise intuitively have a connection and deep understanding of their patients' needs and are able to act on that understanding to provide the care they require. Benner and Tanner (1987) outlined several examples of nurses using their intuition to affect their patients' outcomes. One such example was a nurse who overheard a patient's wife say her husband was not feeling well and was getting very anxious. The nurse knew the patient was at a high risk for complications and she had a suspicion there was something wrong so, despite the patient being assigned to another nurse, she went to investigate. When she entered the room, the patient was pale and anxious, the nurse immediately suspected a pulmonary embolus and called the doctor. Moments later the patient coded (Benner & Tanner, 1987, p. 24).

The nurses also showed how their intuitive practice affected patient outcomes. Kat described a situation in which one of her patients had been extubated and she knew the patient, '*... really wasn't doing well*'. She trusted her intuition so strongly that she initiated NIV and then called the doctor and informed him she had done so, despite procedural stipulation that the treatment required medical approval before commencement. If reaching a point in practice where nurses are intuitively working has beneficial effects on the outcomes of patients, then it is an area worthy of attention.

The importance of Benner's (1984) model of novice to expert was that it showed how nurses are able to acquire new skills and how educators may use this knowledge to teach nurses. The path to clinical intuition adds the importance of context. The manipulation of power and knowledge across relationships between nurses and doctors, other nurses and the institution allows progression of nursing practice towards the point of intuitive practice from an alternative angle. If the basic premise of nursing is to provide positive patient outcomes, and nursing as a profession is striving to become intuitive/expert in practice, then the effect of this transformation on patient outcomes is important.

8.11 Chapter Summary

This chapter has discussed the results of the research project with reference to the context in which the project was conducted as well as the current state of knowledge regarding this topic. The quantitative findings were compared to national and international research that has focused on asthma and the effect of NIV on acute exacerbations of asthma. Issues that were particularly

prominent in the patients in this research were the high rate of smoking in patients with acute asthma and the concurrent diagnosis of gastro-oesophageal reflux disease. The current evidence regarding the effect of NIV on pH, pCO₂ and respiratory rate is conflicting with several studies reporting variable findings. This research found that respiratory rate was significantly affected by NIV, a conclusion that some other researchers have made, but not all.

The qualitative data enriched the quantitative findings and the nurses reported many contextual effects on their practice that inhibited or encouraged them to use NIV. They described traversing along a path to clinical intuition in which they experienced phases of lack of education, isolation, fear, support and mentorship, ownership, leadership and intuition. These factors have previously been reported in the literature as issues that affect the development of nurses. The movement of the nurses on the path to clinical intuition was discussed with reference to the power relations in their individual contexts. Power was examined in reference to the work of Michel Foucault who professed power is not a possession, power is resisted, and power can be made sense of through knowledge. This discussion has contextualised the findings of this research and placed it within the current body of nursing knowledge. The final chapter of this thesis will present the implications, recommendations, reflections and conclusion of the project.

Chapter 9: Implications, Recommendations, Reflections and Conclusion

9.1 Introduction

The purpose of this chapter is to present the implications, recommendations, reflections and conclusion of this research project. The implications of the project for clinical practice, nurses, healthcare institutions and research will be discussed in relation to what the profession, employers, educators and governance of nursing can learn from the results. Strengths and limitations will be presented including a description of processes undertaken by the researcher to negate some of the inherent limitations of a sequential explanatory design. Recommendations for practice will be made in reference to the information that has been gained from this project in relation to the use of NIV and elements of nursing practice. The researcher's reflections on the PhD process and the components of the candidature will be provided to give a personal account of lessons learned, difficulties encountered and personal growth throughout the research journey. A summary of the thesis chapters will then be outlined followed by the conclusion.

9.2 Implications

There are many implications for clinical practice inherent in the results of this project related to the use of NIV, the profession of nursing, and the organisations in which health care occurs.

9.2.1 Clinical Practice

The use of NIV for acute exacerbations of asthma was found to be a feasible and safe treatment. No patients in this project suffered adverse effects as a result of treatment with NIV and there was no patient mortality. It is less obvious if NIV is a better treatment for adult patients with an acute exacerbation of asthma compared to standard medical therapy, although it does appear that the literature and the results of this project trend towards better patient outcomes as a result of the use of NIV. Clinically, this does not translate to a definitive answer as to whether NIV should or should not be used for acute exacerbations of asthma in adults. The implications of this project are that while NIV may be effective for the treatment of asthma, this should only occur in circumstances where close patient monitoring is available and there is a low threshold for escalation to invasive ventilation, particularly if the patient's condition has not improved within the first two-four hours of NIV treatment.

9.2.2 Nursing

This research suggests that reaching a point in practice where nurses are able to practise intuitively is beneficial both for nurses and for patient outcomes. There are several factors that influence nurses' ability to reach this point that should be considered. Firstly, it seems there is a requirement for attention to education strategies, particularly in rural and regional areas. Education should be provided to staff before they are required to use new technology. Secondly, it is also important that regular education is scheduled so that nurses are intermittently exposed to technology and avoid 'skill rusting'. Nurses value face-to-face education but there are significant barriers to attending such education as it is usually held in large centres. Rather than rural nurses travelling to metropolitan areas, it would be beneficial for education to be provided in rural areas. Nurses could facilitate this by forging relationships with larger hospitals and organisations that may be able to provide educators who can travel to rural sites, or they may be able to link through electronic means that allow for interaction such as via telephone or videoconference.

There is also a requirement for nurses to nurture positions of support and mentorship both for themselves and their colleagues. This could occur through the adoption of formal and informal mentorship programs and should be driven by nurses. To cultivate autonomous practice there is a need for a clear definition of what this constitutes, particularly in the context of critical care. It seems that within this specialty area, professional boundaries between nursing and medical staff are becoming blurred. There is little consensus regarding the abilities and responsibilities of nurses in these areas.

Intuition should be accepted as an integral part of nursing care and recognised as such in nurses' scope of practice, education and research. It seems that the presence of intuition as a clinical tool is currently contentious, despite extensive examples of its existence. Nurses should not discount their ability to work intuitively, but should cultivate this practice and study it to increase their understanding of the mechanisms by which they can reach intuitive practice and understand the effect this has on clinical outcomes.

9.2.3 Healthcare Institutions

Throughout this project, it was evident that due to organisational and financial boundaries, hospitals do not place emphasis on the education of their staff when implementing new technologies. This had several significant effects on the likelihood that patients would receive

NIV treatment. If hospitals are willing to implement new technologies with the view of improving patient outcomes, they must also recognise that untrained staff will affect the efficacy of the treatment. Planned education sessions should be held and be open to all members of the multidisciplinary team. The reliance on nurses to teach one another may also mean that it would be beneficial to train select staff as ‘champions’ of the new technology so that there is a support person available for others as they begin to use it. Another factor that the nurses in this project emphasised was that even when they are given training on a new piece of equipment, this cannot be a once-only event. Training should be ongoing and available via multiple mediums to avoid ‘skills rusting’ and feelings of incompetence.

Hospitals should also promote interdisciplinary collaboration and education to enhance the ability of nurses and doctors to work together. This project showed the importance of collaboration between these two professions and the detrimental effects of miscommunication and misunderstanding for the staff and patient outcomes. Nurses and doctors who are able to work cohesively can function as one unit to support, educate and learn from one another, so it is important that interdisciplinary education is designed and implemented. Within the hospital system, emergency clinical situations are attended by both nurses and doctors who must work as a team to treat critically unwell patients. In order for these teams to be able to work together in these situations, they should be trained together. The nurses in this project described the detrimental effects of training doctors and nurses separately to respond to the same situation. They felt it led to confusion and a fragmented treatment plan. Hospitals should invest in their staff by promoting interdisciplinary education to address scenarios in which nurses and doctors must work as a team. This may also include the provision of assertiveness, communication and teamwork training for individuals.

This project has shown the significant implications of isolation on staff. The nurses who felt isolated were less likely to use NIV or feel comfortable with their practice and did not feel supported. Hospitals can address feelings of isolation in many ways. Development of inter-facility support models may decrease feelings of isolation. If nurses working in rural facilities were provided with a link to nurses in larger facilities for the purpose of advice and clinical direction, they may feel more supported. This could simply be a model that allowed nursing staff in EDs in rural facilities to contact senior nursing staff working in specialty areas such as ED or ICU in regional or metropolitan facilities for advice. A similar model already in use in the LHD in which this research was undertaken is the critical care advisory service, a

phone/videoconference service that enables staff to contact critical care specialists for the purpose of clinical advice and retrieval. The nurses interviewed in this project felt that the presence of this service was beneficial and decreased feelings of isolation. Unfortunately, the service is only provided from 0700–2000 hours so, outside of these times it is of no benefit. This is compounded by decreased staff numbers in many facilities overnight. Hospitals that have invested in advisory services should consider the requirement for this support to be constantly available.

Another implication of this research for hospitals to consider is the importance of the establishment of mentorship programs for staff. The results of this study show that support from peers is essential for the development of staff, their clinical skills and their contentment. Hospitals should consider having designated staff members who are responsible for the oversight of these mentorship programs. They could also consider incentives to promote participation in mentorship programs such as career rewards, salary compensation, or time in lieu.

9.2.4 Research

There are several future directions that can be taken in research as a result of this project. Although NIV appears to be a safe and effective treatment for adults with acute exacerbations of asthma, further research is required to confirm this. Definitive guidelines on the use of NIV for asthma cannot be written until this treatment is more thoroughly understood. This includes further studies on the difference in using NIV compared to standard medical therapy, the location of NIV treatment, and the effect of NIV on work of breathing during asthma exacerbations, including patient-reported measures. Considering the ethical issues that would be associated with withholding NIV from patients who might potentially benefit from this treatment, RCTs are inappropriate. The issue with retrospective studies on acute, severe asthma such as this study is the difficulty recruiting large samples of patients. To address this issue, large retrospective studies focused on data from national or international databases would be an appropriate method of data collection to enable a larger sample.

There is a need for further research on the use of intuition in nursing. The discussion in Chapter 8 demonstrated that there has been recognition of the use of intuition in nursing but this phenomenon is still poorly defined and understood. Further research in this area would allow for a description of the phenomenon, how and why it occurs, and how nursing can provide

avenues for staff to reach this point in their clinical practice. Examining the use of intuition in practice would support a description of its effects on patients' outcomes and provide a greater appreciation of this sophisticated and unquantifiable skill by all health professionals.

Further research on the context of nursing including the power relations experienced by nurses and the effect they have on clinical practice is warranted. This is particularly important because of the wide variation in nursing practice and healthcare design internationally. It would be beneficial for nursing as a profession to understand how to better situate itself in a position where power can be used to govern practice and improve patient outcomes, particularly in regard to collegial relationships, knowledge and the role of institutions.

9.3 Strengths and Limitations

Limitations are as inherent in mixed methods projects as they are when conducting a project using qualitative or quantitative processes alone. Creswell (2014, p. 225) identified that one particular consideration when using a sequential explanatory design was that "the accuracy of the overall findings may be compromised because the researcher does not consider and weigh all of the options for following up the quantitative results". Chapter 6 demonstrates the way the qualitative questions were formulated using the quantitative data to enhance rigour, credibility and transparency. This explanation enables the reader to follow the method used to design the qualitative phase of the project.

This project was limited by the use of data from only one local LHD in NSW. This may mean that the results are only generalisable to similar areas. Further, the nine hospitals included in quantitative data collection had been using NIV for a relatively short period of time (only six years for some of the facilities) which may have further influenced the likelihood patients would receive it as a treatment. Although the nurses interviewed were from a diverse range of backgrounds, they were all currently employed in critical care areas so the information they provided may only be relevant within this specialty where there were unique interactions and relationships with the patients and the multidisciplinary teams.

This retrospective study was not able to influence standard medical treatments prescribed to the patients and thus there may have been influences on the efficacy of NIV caused by the presence of certain types of medical therapy. Although statistically there was no difference between the medications received by the patients who were prescribed NIV and those who

were not, this may not reflect clinical response to those treatments. Slight variations in responses to medication regimes may have influenced the efficacy of the NIV treatment.

Data collected for the quantitative phase of this project focused on a patient population that was inclusive of every adult who had presented to one of nine hospitals with a severe exacerbation of asthma within the five-year study period. Patients who did not present to these nine hospitals were not included because they did not have the opportunity to be treated with NIV. This may have resulted in data from patients who would otherwise have met the inclusion criteria not being collected.

The categorisation of severe asthma, according to specific criteria, limited the patients whose data were included in this project. Although the inclusion criteria were based on the local guidelines for the use of NIV, they had to be modified to allow for use in situations where the inclusion criteria data were not documented. This may have affected not only the patients' data included in the project but also the ability to generalise the results to all patients with severe asthma. As previously discussed in section 8.3 of this thesis there is variability in the clinical presentation of adults with acute asthma which creates difficulty when defining inclusion and exclusion criteria for research. The clinical definition of acute asthma used in this research limited the adults included in the study and may have affected the results. Researchers seeking to compare their results to that of this project should take this into account.

Collecting data using interviews also poses limitations to a research project. The relationship between the interviewer and the interviewees should be considered. The researcher held a horizontal nursing position to those who were interviewed and had no ability to affect their practice and careers, but this should still be considered in a critique of this project. It is possible that because the interviewer was known to most of the participants this may have influenced some of the answers given and the way the discussion flowed. It is also possible that the situation of the researcher working as a nurse may have impacted the discussions in the interviews and the areas of emphasis in the qualitative results. A thorough description of positionality was given in Chapter 4 in recognition of this.

Member checking was not undertaken as part of this research. This may have been a limitation as it is possible it affected the accuracy of the interview transcripts. Rigour and credibility was enhanced by the researcher having the interviews transcribed professionally, then checking and re-checking the accuracy of every transcript several times.

This research was designed with the view of achieving inference transferability, which denotes the extent to which the results of a mixed methods project can be applied to other entities or settings (O’Cathain, 2010, p. 549). The detailed description of the research design used and the methods by which this study was undertaken contributes to inference transferability. The quantitative results incorporated the whole patient population that fitted the inclusion criteria for the five-year period from which data were collected. The population studied in the quantitative phase is therefore representative of severe, adult asthma exacerbations in the MLHD. These data may be transferable to other areas with similar demographics and healthcare facilities. There is a limitation in this statement, however, as the MLHD has relatively high rates of asthma compared to other areas in Australia and internationally, so the severity of asthma may have been over represented in this population. In regards to the transferability of the qualitative results, the researcher has attempted to explicitly describe the participants, their context and the positionality of the researcher. The researcher also aimed to provide authentic accounts of the interviews and the voices of the participants resonate throughout and inform this thesis.

9.4 Recommendations

1. NIV should continue to be used for severe asthma in some circumstances

The results of this project reiterate that NIV is a safe treatment for adults with severe exacerbations of asthma. Considered in the context of the population studied, it appears that the use of NIV was beneficial and caused no adverse outcomes. NIV should continue to be used in practice for the treatment of select patients with acute exacerbations of asthma, under the condition that they are monitored closely for deterioration and clinicians are aware of clinical guidelines to guide their treatment.

2. NIV should be implemented as soon as patients meet the criteria for this treatment

This research demonstrated that shorter time to initiation of NIV resulted in significantly improved respiratory rates at 18 hours. This implies that clinicians should apply NIV as soon as patients meet the criteria for the treatment so that the time required for improvement in respiratory rate is decreased.

3. Work of breathing should be used as a subjective measure of a patient's response to NIV treatment

Work of breathing was used as a measure of patient response to treatment by all the nurses who were interviewed in this research. As one of the goals of NIV treatment is to alleviate increased work of breathing, and previous research has shown that NIV affects this parameter, clinicians should institute methods of measuring work of breathing in patients who receive NIV. This data may assist clinicians to identify patient deterioration and to differentiate between fatigue and improvement. It could also be used in future research to examine if a relationship exists between work of breathing and patient outcomes.

4. The concurrent occurrence of asthma and smoking needs to be addressed in terms of cessation and treatment alteration

The number of people admitted to hospital with acute exacerbations of asthma who were current smokers was notable in this study. This phenomenon was similarly described in the literature. As a result, organisations should review the current programs focused on decreasing the number of people who smoke. This may include targeting people with chronic lung conditions such as asthma as priority areas. Smoking has been shown to cause an increased risk of exacerbation of asthma and a decreased response to asthma treatments. The LHD in which this project was undertaken should particularly take note of this issue and address smoking in people with chronic lung conditions.

5. Concurrent diagnosis of gastro-oesophageal reflux disease and asthma should be further explored within the MLHD to determine if patients are on appropriate treatment plans

Gastro-oesophageal reflux disease was one of the most prevalent comorbidities in the population of patients in this research who had a severe asthma exacerbation. Considering past research has demonstrated that asthma can be exacerbated by this condition, a local investigation into the treatment of gastro-oesophageal reflux disease for patients who have asthma is appropriate. Primary health clinicians responsible for the concurrent treatment of these diseases should be provided education on the link between asthma and gastro-oesophageal reflux disease and appropriate treatments.

6. The critical care advisory service in the MLHD should be operational 24 hours a day, seven days a week

To decrease the isolation of staff in rural facilities and provide support when they are practising skills used infrequently, the critical care advisory service is essential. The nurses in this study identified that the absence of this support as a permanent, constantly available service was an

issue. The MLHD should consider immediate expansion of the critical care advisory service to a model that operates 24 hours a day, seven days a week.

7. Hospitals must promote interdisciplinary training and collaboration

The importance of interdisciplinary training and collaboration has been outlined throughout this project. Hospitals must facilitate this training and should commence, at a minimum, combined training for staff in specialty areas such as EDs and ICUs where they must work together in teams. This should include training in emergency situations such as treatment of patients in acute respiratory failure. Staff collaboration is similarly important and can be achieved through various means such as research, groups of special interest and journal clubs. Hospitals should consider the means by which they currently enable interdisciplinary training and collaboration and aim to increase the number of these programs.

8. Healthcare organisations should develop strategies for immediate and reoccurring information to be sent to staff regarding the clinical guidelines that are available to guide their practice

There is an obvious disconnect between the presence of clinical guidelines and staff awareness that they exist. This should be addressed at both the facility and health district level. Firstly, consultation groups for the creation and review of guidelines should be defined and should mandatorily include staff for whom the guidelines are being developed. This will promote stakeholder involvement and, as a result, may increase the number of staff aware of guidelines. Secondly, health districts should ensure they have a central, accessible system for filing of guidelines. Staff must have immediate access to this system and access to a list of guidelines currently available within their specialty area as well as the ability to provide feedback.

9. The MLHD should design a program that enables rural facilities to link with larger facilities for the purposes of education, support and clinical advice

Despite the presence of the critical care advisory service and the ability for rural hospitals to contact specialists by phone, many of the nurses in this study reported feelings of isolation and discussed the negative effect this had on their practice. A method to address this would be to provide nursing staff in rural areas with a link to a larger facility such as regular meetings, combined education, collaborative projects, or site visits. Staff could also be offered the opportunity to work in different facilities for short periods to gain clinical experience. These links would decrease feelings of isolation, improve patient care, and streamline inter-hospital transfers between rural and regional sites.

10. Assertiveness training for nurses should be provided to encourage empowerment and autonomy, considering the implications these skills have on patient care

Considering the importance of communication and the current imbalance of power in collegial relationships in hospitals, the whole culture of the institution needs to be imbued with an appreciation of assertiveness, empowerment and autonomy. Staff should be offered education on communication strategies and teamwork. Multidisciplinary collaboration will also encourage cross-disciplinary respect and the opportunity for colleagues to work together across different fields.

11. Hospitals should design and govern mentorship programs

As has previously been discussed, support and mentorship provided by these programs are essential for the support and development of staff, decreasing feelings of isolation. Hospitals should design and implement mentorship programs that are governed within the hospital and overseen by a dedicated employee.

12. The importance of intuition in clinical nursing practice must be recognised

Intuition was identified in this research as an important component of nursing practice and a phenomenon that nurses often use in their clinical decision-making. Intuition should be recognised as a skill that can be acquired by nurses and used to influence positive patient outcomes. This is particularly regarding the recognition of deteriorating patients which was intuitively recognised by some of the nurses in this research. Possible directions for the exploration of intuitive practice include observational studies focused on the description of intuitive practice; research focused on the development of nurses into intuitive persons, or whether intuitive people become nurses; and the effect intuitive practice has on patient outcomes.

9.5 Reflections

In my final pages, I would like to provide some brief reflections of the past three years and my journey through the PhD candidature. It is evident that this period has largely been one of change: intellectually, physically and emotionally. Despite the challenges encountered, I reflect on my candidature with satisfaction and pride.

9.5.1 An Existential Crisis

It is probably through the steep learning curve of the PhD combined with trying to be a clinician, a partner, a family member, a friend, a colleague, a researcher and a student that

caused serious confusion about my place in the world. Combine this with in-depth study of philosophy and the result is serious consideration of what it means to be all of these things at once. I wondered a lot throughout my candidature where I sat within my profession – was I a student, a researcher, or a nurse? The conclusion I came to is that I am all of these things and am proud to have had the opportunity I have had in each domain. I am sure, much like the knowledge produced from my project, that my person remains subject to change, but I have learnt to enjoy being what I am and am eager for the next challenge, despite what it may add to the mix.

It seems strange to me to look back not only at how I have grown as a nurse and a researcher, but how I have changed as a person through this process. The skills I have gained in analysis and literacy are nothing compared to the change in the way I think. I approach problems differently, analyse relationships contrarily, and nurse in a completely different way. These changes may be for the better, or the worse, but regardless, they are present. I think doing a PhD has a particularly influential effect on life because it is all-consuming. There has not been a day since I began that I have not thought about my project. It came on holidays, was with me when I was sick, was present at work, and nagged me when I was with friends. I have considered the possibility that life without my PhD may be lonely, but I think the satisfaction I feel when reflecting on this journey will allow me peace and the ability to look back nostalgically.

9.5.2 Supervision

Supervision seems to be an ever-contentious process in academia. Sometimes the relationship goes well, sometimes not so well, and sometimes terribly. I have naturally spent a lot of time with other candidates over the past few years and have certainly seen examples of each of these. Fortunately, my experience was the former. I developed a strong and trusting professional relationship with my primary supervisor that I can honestly say was one of my greatest assets throughout this process. I could not possibly count the number of lessons I gained from my supervisor but there are two particular points that will stay with me forever, the importance of questioning and the importance of taking people on the journey.

The way people supervise matters. It changes not only the quality of the candidature but also the quality of the learning. I have now spent years watching fellow candidates who have poor relationships with their supervisors struggle to understand threshold concepts, particularly

theory. Poor supervisory relationships affect their ability to grow. Conversely, my supervisor demanded growth. She challenged me, asked me for my opinion and supported me to take control of my project. When I first started researching, I would describe my project as something ‘we’ were undertaking. This was because I was so afraid of the process and putting my unworthy name to it that I felt I needed her to claim part-ownership of it. She made me take that ownership and supported me to do so. She showed me my worth as a researcher and that every person has a right to question.

Aside from the education I received from my supervisor, she also taught me personal lessons. She told me from the beginning of my candidature that I must take my family and friends with me on the journey. I adhered to this advice and am so glad I did. I spent days locked in a room with one of my sisters while she completed her Honours thesis and celebrated every possible milestone with my partner while experimenting with theoretical ideas with him. Many members of my family are from a healthcare background, so I tested ideas on them. This lesson was one of the most important things my supervisor could have taught me during my candidature as it expanded my support network and allowed me to have connections with people that may not have otherwise survived.

9.5.3 The Writing Process

A major discovery I made during my candidature is how difficult the writing process is. Writing is not just putting words on paper – it is thinking, analysing, arguing and deciding. I would often feel that I had finished with a particular piece of work only to revisit it months later and change my mind. I think this is inherently linked to the way my thought processes and opinion changed over the years. When I would go back and read work from the first year of my candidature I would often have completely changed my opinion about what was important in that body of work. In the beginning, writing was easier. I read, critiqued and wrote. As I worked my way deeper into my project, putting words on paper became the smallest part of the writing process. All the thinking and circle-work done in the times there were no words going onto the paper, took up the largest portion of the process. I think I learnt the most during this time. If there is one thing I can credit the writing process for, it is showing me the value of reflection.

9.5.4 I Am, First and Foremost, a Nurse

I think it was valuable that I continued to work as a nurse throughout my PhD candidature. When I would have periods of blank thoughts I would go to work and ask my colleagues –

‘What do you think about this?’ They would inevitably provide me with a discussion that brought on new insights. I also feel that continuing to work as a nurse kept me connected to my research. I continued to use NIV in my workplace, and to treat patients with asthma. This generally also allowed me insights and understandings I may not have otherwise had.

Continuing with my clinical career also presented difficulties. Critical care units are inherently stressful, high stake workplaces that engage thoughts and emotions that nurses often cannot leave at work. The divide between clinical nursing and nursing research also remains present. A nurse doing a PhD still seems to be an elusive butterfly. I lost count of the amount of times people asked me ‘Why?’ Research to me is something so important to our profession. I spent a lot of time trying to promote research in my clinical environment while completing my candidature. I felt grateful that I could still be part of the clinical workplace that I am so passionate about, and it is very rewarding to try to ‘pay it forward’ by engaging my workplace with research.

I feel that through my research I have become closer to my profession. My understanding not only of clinical practice but of the reasoning beyond clinical practice has been expanded. The interviews I conducted with the nurses were deeply emotive for me, something I had not expected. I felt proud of the nurses, inspired by what they do and honoured to be a part of such a profession. I am unquestionably a nurse, and very proud of it.

9.6 Conclusion of Thesis

The purpose of this thesis was to report on an examination of the use of NIV for acute exacerbations of asthma in adults. The first chapter of this thesis described the background and context of the project. The research was designed to investigate the use of NIV for acute asthma because there is currently a paucity of evidence to support this practice. The background investigation showed that NIV may be a beneficial treatment for patients with acute exacerbations of asthma and is currently being used for this purpose. It was also shown that asthma is a significant chronic respiratory condition internationally, but has a particularly high prevalence in Australia.

The second chapter was a literature review which critiqued the current available evidence for the use of NIV for asthma and the effect of its introduction on nursing practice. The review showed that there was not enough evidence to recommend the use of NIV for asthma, although

research previously conducted had encouraging results. It also demonstrated that the current evidentiary base for this practice is widely variable in regards to project designs and outcomes measured. The second phase of the literature review that examined the effect of the introduction of NIV on nursing practice showed that very little research had previously examined this issue. It was found that nurses generally considered NIV an effective clinical tool, but the implementation of NIV was associated with issues such as lack of education provision, need for collaboration, and guideline variability.

The philosophical assumptions and methodological basis for this research project were discussed in Chapter 3. This project was based on the assumptions of John Dewey's pragmatism which places importance on the practical use of the research. The philosophical assumptions that were adhered to include the existence of multiple truths, the importance of perception in relation to what is real, the fallibilism of knowledge, rejection of scepticism, the influence of context on experience, and the value of ideas as tools for inquiry. Using these assumptions, a mixed methods study was designed.

The specific type of mixed methods used in this project was a sequential explanatory design, as was outlined in Chapter 4. The research was conducted in two distinct phases: a quantitative phase followed by a qualitative phase. The two phases were integrated at two points within the project. At the end of the quantitative data analysis, the results of this phase of the project were used to design questions that would be used in qualitative interviews. After the qualitative data had been collected and analysed, the two sets of results were integrated to examine overlaps and explanations.

As a result of the sequential explanatory design, three chapters were dedicated to the presentation of the results. Chapter 5 outlined the results of the quantitative data analysis and determined that NIV is a safe treatment for acute exacerbations of asthma in adults. Chapter 6 articulated the results of the qualitative data analysis, including the design of the research questions and the themes produced in the interviews when nurses were asked about their experiences with NIV. The themes included lack of education, isolation, fear, support and mentorship, ownership, leadership and intuition. The interviews with the nurses showed movement through these themes which I have described as the path to clinical intuition. It was identified that although the nurses generally progressed along the path, they always had the opportunity to move backwards or remain stagnant at any point.

Chapter 7 reviewed the results of both the quantitative and qualitative data to determine the areas of overlap, particularly areas in which the qualitative data were able to provide depth or explanation of some of the quantitative findings. This provided information regarding why some clinicians may not use NIV, the reasons clinicians may not follow clinical guidelines, the effect of time of day and clinical skill mix on patient treatment, the type of education offered to staff when NIV was introduced into their practice, who was responsible for initiating NIV treatment, interdisciplinary collaboration, the support available in rural facilities, the indicators of respiratory failure, and the location of NIV use.

The results presented in Chapters 5, 6 and 7 were discussed in Chapter 8 in regards to where these findings sit within the information and evidence that is currently available. The discussion identified that within the context of the current evidence, NIV is an appropriate treatment for acute exacerbations of asthma in adults, but should be used cautiously and monitored carefully. The factors that influenced the clinical practice of the nurses were then examined in relation to their movement along the path to clinical intuition. There were many individual and related concepts that affected the way the nurses moved but they were heavily influenced by collegial power, the power of knowledge and the power of the institution. The path to clinical intuition was then situated within nursing as a complementary model to that of Benner's novice to expert. Benner (1984) described the progression of nurses in regards to their skill acquisition while the path to clinical intuition described their progression in relation to power and context. Both models end at the same point where a nurse reaches an intuitive position of expert practice. To reach this point in practice the nurses in this research had to overcome challenges associated with the institution in which they were employed as well as their colleagues and the acquisition of knowledge.

Chapter 9 has presented implications, recommendations and reflections. The research has several implications for clinical practice, nursing, healthcare institutions and research. Recommendations covering each of these areas were proposed so that treatment of patients with acute exacerbations of asthma can immediately be altered to reflect the results of this research. The purpose of these recommendations is to ensure patients receive the most appropriate treatment for acute exacerbations of asthma and clinicians are able to deliver these treatments effectively.

In conclusion, this research project was undertaken to examine the use of NIV for acute exacerbations of asthma. Retrospective data were collected to determine the effect of NIV on

patients' pH, pCO₂, respiratory rate, ICU length of stay, hospital length of stay, and mortality, compared to standard medical therapy. Neither the group who received NIV nor the group who received standard medical therapy had any adverse events or mortality. The group who received NIV did have an improved respiratory rate compared to the group who received standard medical therapy, but this was affected by the interaction of time. In recognition of the influence of context on the ability to provide treatment, qualitative data were collected to enrich the quantitative findings and provide an explanation as to why some of the quantitative findings occurred. Nurses who used NIV in practice were interviewed and they explained several effects on their practice including education, isolation, fear, support and mentorship, ownership, leadership and intuition.

This project has demonstrated that treating patients with NIV is complex and although NIV is appropriate for patients with acute exacerbations of asthma, the ability of nursing staff to provide this treatment is heavily influenced by the context in which they work. The effect of context on clinical practice must be considered in the design, implementation and governance of NIV and other treatments so that the needs of both clinicians and patients can be met into the future.

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Appendix A: Recruitment Flyer



RESEARCH PARTICIPANTS NEEDED

PURPOSE:

You will be participating in the second part of a larger study. The first part of the study is aimed at determining if noninvasive ventilation is a better treatment for asthma compared to standard medical therapy. The second part of the study (which you will participate in) is aimed at exploring the experiences of nurses working with new technologies, in particular, noninvasive ventilation.

ELIGIBILITY:

You are eligible to participate in this project if you are:

- A nurse
- Currently working in an emergency department, high dependency unit or intensive care unit that utilises noninvasive ventilation as a treatment for acute respiratory failure
- Are employed in a public hospital in (site names removed to protect participant identity)

PARTICIPATION:

If you contact the researcher and register your interest to participate, you will be taken through the design of the project thoroughly and given the chance to ask any questions before giving your consent to participate. Once you consent, the researcher will arrange a time and place to suit you and will conduct an interview which will include the researcher asking you questions about your work, particularly in relation to noninvasive ventilation.

BENEFITS:

The benefit of this study for nurses is that it will help guide practice related to noninvasive ventilation and will also assist policy makers to implement new technologies in a way that incorporates the needs of nurses.

COST:

Participating in this study is free and you will not be paid for your participation.

CONFIDENTIALITY:

Any identifiable information that is collected about you in connection with this study will remain confidential and will be disclosed only with your permission, or except as required by law. Only the researcher named above will have access to your details and results that will be held securely at Charles Sturt University. You have the right to withdraw from the project at any time.

CONTACT:

To register your interest in participating in this study or to get further information please contact:

Elyce Green

Elyce.green@gsahs.health.nsw.gov.au or 02 6938 6618

Appendix B: Participant Information Sheet



PARTICIPANT INFORMATION SHEET

A quantitative and qualitative inquiry into the use of noninvasive ventilation to treat acute asthma in adults: a multi-site study

Chief Investigator:

Elyce Green (B Nursing/B Clinical Practice (Paramedics), Nursing Honours (Class 1), Master of Nursing (Critical Care), PhD Candidate

Project Supervisors:

Dr Maree Bernoth, Senior Lecturer School of Nursing Midwifery and Indigenous Studies, Charles Sturt University

Dr Paras Jain, Intensive Care Specialist, Wagga Wagga Rural Referral Hospital

Invitation

You are invited to participate in a research study which has been designed to examine the use of noninvasive ventilation for acute asthma and explore the experiences of nurses using noninvasive ventilation.

The study is being conducted by Elyce Green, Registered Nurse ICU Wagga Wagga, PhD Candidate Charles Sturt University Wagga Wagga.

Before you decide whether or not you wish to participate in this study, it is important for you to understand why the research is being done and what it will involve. Please take the time to read the following information carefully and discuss it with others if you wish.

1. 'What is the purpose of this study?'

You will be participating in the second part of a larger study. The first part of the study is aimed at determining if noninvasive ventilation is a better treatment for asthma compared to standard medical therapy. The second part of the study (which you will participate in) is aimed at exploring the experiences of nurses working with noninvasive ventilation.

2. 'Why have I been invited to participate in this study?'

You are invited to participate in this study because you are a nurse working in an area that has access to noninvasive ventilation and therefore have unique insight into the way noninvasive ventilation is used and what influences your practice.

3. 'What does this study involve?'

If you agree to participate in this study, you will be asked to sign the attached consent form. Once you consent, the researcher will arrange a time and place to suit you and will conduct an interview which will include the researcher asking you questions about your work, particularly in relation to noninvasive ventilation. The questions are not designed to be

intimidating, but to get your perspective of this issue. There are no right or wrong answers, the researcher is just looking for your experiences and opinions.

This study will be conducted over the course of 2015-2017, but the interviews will take place throughout the second half of 2016.

4. ‘Are there risks to me in taking part in this study?’

The only foreseeable risk of you participating in this study is the possibility of you feeling discomfort by being interviewed by someone you do not know. Every effort will be made to ensure you feel comfortable.

5. ‘Will I benefit from the study?’

This study aims to further medical knowledge and may improve future treatment of asthma using noninvasive ventilation. It may also provide benefits to nurses and those that implement new technologies as they will be able to incorporate the reported experiences of nurses into future technology implementation.

6. ‘How is this study being paid for?’

The study is being funded by an Australian Postgraduate Award which was awarded to the principal researcher to fund the PhD candidature.

7. ‘Will taking part in this study cost me anything, and will I be paid?’

Participation in this study will not cost you anything, nor will you be paid.

8. ‘What if I don’t want to take part in this study?’

Participation in this study is voluntary. It is completely up to you whether or not you participate. Your decision to participate or not will not affect your employment in any way.

9. ‘What if I participate and want to withdraw later?’

You have the right to withdraw from the study at any time. If you withdraw, any information or material you have provided will also be withdrawn from the study. You can withdraw by contacting the principal researcher by phone or email and stating you would like to withdraw. You do not need to give reasons for your withdrawal.

10. ‘How will my confidentiality be protected?’

Any identifiable information that is collected about you in connection with this study will remain confidential and will be disclosed only with your permission, or except as required by law. Only the researchers named above will have access to your details and results that will be held securely at Charles Sturt University.

11. ‘What happens with the results?’

The study results will be written in report form and presented as a thesis for the PhD candidate’s final assessment. The results may be presented at a conference or in a scientific publication, but information will be provided in such a way that you cannot be identified.

12. ‘What should I do if I want to discuss this study further before I decide?’

When you have read this information, Elyce Green will discuss it with you and answer any queries you may have. If you would like to know more at any stage, please do not hesitate to contact her on 02 6938 6618.

13. ‘Who should I contact if I have concerns about the conduct of this study?’

This study has been approved by Greater Western Human Research Ethics Committee and Charles Sturt University’s Human Research Ethics Committee. Any person with concerns or complaints about the conduct of this study should contact:

- Ms Deborah Shaw who is the person nominated to receive complaints from research participants for the Greater Western Human Research Ethics Committee. You should contact her on 02 6330 5941 and quote [insert HREC reference number],

or

- Charles Sturt University’s Human Research Ethics Committee at
The Executive Officer
Human Research Ethics Committee
Tel: (02) 6338 4628
Email: ethics@csu.edu.au
Any issues you raise will be treated in confidence and investigated fully and you will be informed of the outcome.

Thank you for taking the time to consider this study.

If you wish to take part in it, please sign the attached consent form.

This information sheet is for you to keep.

Appendix C: Consent Form

PARTICIPANT CONSENT FORM

A quantitative and qualitative inquiry into the use of noninvasive ventilation to treat acute asthma in adults: a multi-site study

I have read the attached Participant Information Form on the above named research study, and understand the purpose and procedures described within it.

I understand that the project will be conducted as described in the Participant Information Sheet, a copy of which I have retained.

I have been made aware of any known or expected inconvenience, risk, discomfort or potential side effect and of their implications as far as they are currently known by the researchers.

I agree that research data gathered from the results of the study may be published, provided that I cannot be identified.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this study and understand that I can withdraw at any time.

I understand that I will be given a signed copy of this document to keep.

Participant's name (please print):

.....

Signature:

Date:

Appendix D: Ethics Approval Letters



19th February, 2016
Elyce Green
64 Mima Street
Glenfield Park NSW 2650

Dear Elyce Green,

*Greater Western Human Research Ethics Committee
(HREC) Project No. HREC/15/GWAHS/122*

*A quantitative and qualitative inquiry into the use of noninvasive ventilation to treat asthma
in adults: a multi-site study
Application for Ethical Review*

The Greater Western HREC has been accredited by the NSW Ministry of Health as a lead committee to provide the single ethical and scientific review of proposals, to conduct research within the NSW public health system. Further, this committee is constituted and operates in accordance with the National Health and Medical Research Council's National Statement on Ethical Conduct in Human Research and the CPMP/ICH Note for Guidance on Good Clinical Practice.

Thank you for providing an amendment requested by the HREC for the above project, which was initially reviewed at their 2nd December 2015 meeting. I am pleased to advise that the HREC has granted ethical approval for this research project.

This HREC approval letter constitutes ethical approval only. You are required to submit a site specific assessment application for each site at which you wish to conduct this project. You must not commence this research project at a site until separate authorisation from the Chief Executive or delegate of that site has been obtained. A copy of this letter must be forwarded to all Principal Investigators at every site for submission to the relevant Research Governance Officer as part of the site specific assessment process.

The following documentation has been reviewed and approved by the HREC:

- NEAF submission – AU/1/AA34212 dated 18/02/2016
- Appendix 1. Study protocol. Version 2 dated 17/02/2016
- Appendix 2. Interview Questions. Version 1 dated 05/11/2015
- Appendix 3. Recruitment Flyer. Version 1 dated 05/11/2015

- Appendix 4. Participant Information Sheet and Consent Form. Version 1 dated 05/11/2015
- Appendix 5. Quantitative Data. Version 3 dated 18/02/2016
- Appendix 6. Relevant State Law. Version 2 dated 04/01/2016
- Appendix 7. Survey Monkey Security and Privacy. Dated 23/11/2015
- Appendix 8. Data Management Flow charts. Version 2 dated 18/02/2016

The project is approved to be conducted at the following NSW Public Health sites:

- Wagga Wagga Hospital
- Narrandera Hospital
- Leeton Hospital
- Griffith Hospital
- Deniliquin Hospital
- Tumut Hospital
- Young Hospital
- Cootamundra Hospital
- Temora Hospital

Please note the following conditions of approval:

1. The coordinating investigator will immediately report anything which might warrant review of ethical approval of the project in the specified format, including any unforeseen events that might affect continued ethical acceptability of the project.
2. Proposed changes to the research protocol, conduct of the research, or length of HREC approval will be provided to the HREC for review in the specified format.
3. The HREC will be notified, giving reasons, if the project is discontinued at a site before the expected date of completion.
4. The coordinating investigator will provide an annual report to the HREC and at completion of the study in the specified format.

HREC approval is valid for five years from the date of this letter.

Should you have any queries about your project please do not hesitate to contact the Greater Western HREC Executive Officer on (02) 6330 5889 or via email WNSWLHD-EthicsCommittee@health.nsw.gov.au.

Please quote HREC Reference No. **HREC/15/GWAHS/122** in all correspondence.

The HREC wishes you every success in your research.

Yours sincerely



David Turcato
Executive
Officer GW
HREC

5 May 2016
Ms Elyce Green
64 Mima Street
GLENFIELD PARK NSW 2650

Dear Ms Green

HREC reference number: HREC/15/GWAHS/122

SSA references: SSA/16/MLHD/16, SSA/16/MLHD/17, SSA/16/MLHD, 18,
SSA/16/MLHD/19, SSA/16/MLHD/20, SSA/16/MLHD/21, SSA/16/MLHD,23,
SSA/16/MLHD/24, SSA/16/MLHD/25

Project title: A quantitative and qualitative inquiry into the use of noninvasive ventilation to treat acute asthma in adults: A multi-site study.

Thank you for submitting an application for authorisation of this project. I am pleased to inform you that authorisation has been granted for this study to take place at the following sites in Murrumbidgee Local Health District (MLHD):

- Leeton Hospital
- Deniliquin Hospital
- Young Hospital
- Cootamundra Hospital
- Temora Hospital
- Wagga Wagga Rural Referral Hospital
- Narrandera Hospital
- Tumut Hospital
- Griffith Hospital

Documents reviewed/authorised for use at the sites are as follows:

- National Ethics Application Form, submission code AU/1/M34212
- HREC approval letter dated 19 February 2016
- Appendix 1. Study protocol version 2, dated 17/02/2016
- Appendix 2. Interview questions version 1, dated 05/11/2015
- Appendix 3. Recruitment flyer. version 1 dated 05/11/2015
- Appendix 4. Participant information sheet and consent form version 1, dated 05/11/2015
- Appendix 5. Quantitative data version 3, dated 18/02/2016
- Appendix 6. Relevant State Law version 2, dated 04/01/2016
- Appendix 7. Survey Monkey security and privacy, dated 23/11/2015
- Appendix 8. Data management flow charts version 2, dated 18/02/2016

- CV of researcher (Elyce Green)

The following standard conditions apply to this research project. These are additional to those conditions imposed by the Human Research Ethics Committee that granted ethical approval:

1. Please inform the research governance officer in writing if the project either:
 - a. does not commence, or is
 - b. subject to significant delays in commencing, or is
 - c. discontinued before expected completion.
2. Proposed amendments to the research protocol or conduct of the research which may affect the ethical acceptability of the project, and which are submitted to the HREC for review, must be copied to the research governance officer.
3. Proposed amendments to the research protocol or conduct of the research which may affect the ongoing site acceptability of the project, must be submitted to the research governance officer.
4. Serious or unexpected adverse effects or unforeseen events that are reported to the HREC that approved the study should also be reported to the research governance officer.
5. An annual 'site progress report' should be submitted to the research governance officer. The first will be due one year from the date of this letter. An electronic template for this report is attached with the emailed copy of this letter; templates are also available from the research governance office or email, jill.reyment@gsahs.health.nsw.gov.au
6. As part of the standard monitoring process for authorised research, occasional site audits by the Research Governance Officer will be conducted in MLHD. If your project/site is randomly selected for an audit you will be given ample notice and instructions.
7. On completion of your study, a copy of the final report, as submitted to the HREC that approved the study, should be forwarded to the research governance officer.

Please contact Jill Reyment, Acting Director Clinical Governance at the address below with an alternative date, if you wish a different start date to be recorded.

If you have any queries about this SSA, please contact the research governance office on 02 6933 9169 or email john.connors2t@gsahs.health.nsw.gov.au

Yours sincerely



Jill Reyment
A/Director Clinical Governance
Murrumbidgee Local Health District