Introduction

A lot of work has been undertaken to determine the most appropriate coverage of nursing staff for patients with varying dependency needs. Arthur and James (1994) concluded that a perfect workload measurement system is unlikely to ever exist. In an extensive review of the early literature, they emphasized the
multifunctioning activity of nursing and were critical of methods measuring the demand for nurses as these did not place sufficient emphasis on their non-physical activity. In a recent review, O’Brien-Pallas et al. (2001) were critical of the supply and demand approaches that have dominated attempts to predict nursing resources. They concluded that there has been limited progress in developing models with sufficient complexity and rigour to clearly understand future planning of nursing needs and with a focus on quality care.

Specific measures to determine nurse staffing in neonatal units were developed in the UK a decade ago. Williams et al. (1993) used nursing tasks to develop a classification system of required nursing hours in a neonatal intensive care unit (NICU); however, the authors warned that the descriptors used did not necessarily reflect the nursing workload. External factors such as the geographic layout of the nursery and work practices need to be considered. Similarly, the Northern Neonatal Network (NNN) (1993) also in the UK undertook a prospective survey of activity in 17 neonatal nurseries. The researchers in this study developed a simple classification system based on activity, hours of care and nursing staff ratios that could be used across a variety of neonatal units. They concluded that a standardized method of measuring workload is desirable to enable comparisons between NICUs (Yoxall et al. 2001).

Different approaches have been developed to measure what nurses do for resource planning. Holcomb et al. (2002) examined a method for measuring nursing productivity within the context of evaluating a model of care delivery. In their productivity model, patient care hours, occupancy and salaries together with productive and non-productive hours were examined for a defined period. The authors recommended that more research is required on the relationship between care delivery models and nursing productivity. They warned that other factors such as staff experience and competence level can affect the impact of productivity. In addition, work place practices, the team cohesiveness, unit culture and the layout of individual units may impact on the nurses’ work and the workload for the individuals.

The measurement of nurse staffing levels, workload and productivity must consider the unique characteristics of the individuals performing the work. In a study in 68 hospitals in the USA, Mark (2002) found that larger units with more beds, higher levels of technology and patient acuity were associated with the nurse’s perceptions of inadequate staffing. Other factors such as the unpredictability of patient care, shift variances and support services influenced the individual nurses’ perception of staffing levels. The nurses in Mark’s study believed that poor staffing is coupled with decreased quality of care. This belief would be supported by the majority of sites worldwide. Pollack and Patel (2002) have challenged researchers to examine the delivery of care and bedside care factors when studying the effects of staffing and quality patient outcomes.

A qualitative approach was used by Fagerstrom et al. (2000) with a different emphasis for measuring nursing workload. The bedside nurses assessed the level of nursing care intensity required by their allocated patients. Fagerstrom and Rainio (1999) described the optimal level of nursing care intensity as a balance between the patient’s needs for care and the number of nurses available to provide the care. Rauhala and Fagerstrom (2004) have shown a useful relationship between the patient’s requirements and an optimal level of care. This focus has the potential to take into consideration the individual characteristics of the nurse, such as experience and skill as well as the fluctuating needs of sick infants and their families.

Rationale for study

The accurate measurement of workload has been a concern of managers and consultants working in the 10 NICUs in the states of New South Wales (NSW) and the Australian Capital Territory (ACT), Australia. This network of NICUs provides information for workforce planning in the development of new NICUs or expansion of existing facilities. The reporting of NICU activity has traditionally been restricted to bed occupancy and the number of infants requiring ventilator support. The use of these two parameters alone has been considered by nurse managers to be an inadequate method to determine workload and the capacity of the NICUs to admit infants from the statewide retrieval service for sick neonates. This led the authors to search for more appropriate methods of determining the nurse staffing needs for sick newborn infants.

The purpose of this study was to examine traditional workload measures and new innovative methods to find a comprehensive method of measuring nursing workload in NICUs with differing case mix. The study sites were two NICUs, one in a perinatal centre (perinatal) and one in a predominately neonatal surgical unit in a children’s hospital (children’s). Each unit cares for high-risk infants and are part of the statewide neonatal services network. The units differed in layout, work practices and organizational culture.
Aims

• To measure nursing workload in two NICUs, one in a perinatal unit and one in a children’s hospital.
• To compare different approaches in workload measurement tools in each setting and to current staffing levels.
• To determine if a particular tool could be recommended for measuring nursing workload in various NICUs.
• To see if experience and skill-mix is a variable for measuring nursing workload.
• To determine if other organizational factors contribute to the nurses workload.

Method

A 5-month prospective study involved front-line clinical nurses in both units who scored their patients’ level of dependency in each shift using two recognized measures of patient dependency. The nurses also scored their professional assessment of the level of intensity of care required by the infants allocated to them. The daily bed occupancy and a record of the nurses’ experience in their current place of employment were recorded for the three shifts in a day.

Serial measures of severity of illness scores [Score for Neonatal Acute Physiology (SNAP)] for each patient were obtained either every third day by manual collection in one unit (perinatal) or via daily computerized collection in the other unit (children’s) for all infants for a 5-month period from September 2001–January 2002. The manual scores were determined by one person and randomly checked by one of the researchers.

Institutional ethics approval was given to the study and covered the collection of de-identified patient data. The nurses who participated in the study gave their consent following the distribution of an information sheet and attendance at educational sessions prior to the commencement of data collection.

Tools

Northern Neonatal Network (1993) is a UK-based tool that estimates nursing hours required for four levels of dependency. This is a specific neonatal tool which has been used in previous studies on nursing workload in perinatal centres.

Patient Dependency Tool (Soliman 1998) is a tool that estimates the nursing hours required for seven components of care scored at five levels of dependency. This tool has been in use at one hospital (children’s) for several years and has been validated for use in the neonatal nursery.

Professional Assessment of Nursing Care Intensity Level (PAONCIL) (Fagerstrom et al. 2000) is a 25-point linear tool scored by nurses as to the level of intensity of care required by their allocated patients. Descriptors for each level of intensity were available to assist the nurses. System factors are rated as contributing to an increase, decrease or no change in their workload. This measure takes into account the perceptions of individual nurses to provide an optimal level of care.

Score for Neonatal Acute Physiology (Richardson et al. 1993) scores the worst physiological derangement in each organ system for 76 categories specific to neonates. The SNAP score highly correlates with the nursing workload \((r = 0.59)\), therapeutic intensity \((r = 0.78)\), physician estimates of mortality risk \((r = 0.65)\) and length of stay \((R^2 = 0.59)\) as in previous studies.

Statistical analysis

All variables collected were entered into a database (MS Access) and summarized by descriptive statistics using SPSS v11 (SPSS Inc. 1989–2002 Lead Technologies Inc., Chicago, IL, USA). Pearson correlation and regression were used to examine the relationships between continuous variables. Odds ratios were used to quantify the relationship between various factors and workload.

Results

Data were obtained from a total of 359 patients in two neonatal units in two hospitals. A total of 4368 bed days occurred during the study period (perinatal 1885, children’s 2483). The mean daily bed occupancy varied from 74% (SD 9.3%) in the perinatal unit and 83% (SD 12.2%) in the children’s hospital unit. The ventilator bed occupancy rate varied from 58% (SD 12.6%) in the perinatal unit to 29% (SD 12.6%) in the children’s hospital unit.

A total of 12 649 scores were obtained which estimated nursing hours using two patient acuity tools, the Patient Dependency Score (PDS) and the Northern Neonatal Network-Dependency Tool (NNN-DT). The nursing hours required were estimated by the two acuity tools and were compared to the actual hours provided with the current staffing of both units (Table 1). The discrepancy in hours varied between the two measures in both units. The PDS tool demonstrated a closer
estimate to the current staffing practices whereas the NNN-DT underestimated the hours required.

Two hundred and eighty-four clinical nurses were involved in the study, 98 in the perinatal unit and 186 in the children’s hospital unit. There was a daily average of 22 nurses in the perinatal unit and 23 nurses in the children’s hospital unit who worked three shifts. The nurses in the perinatal unit on an average had more experience in each shift, 3–10.3 years compared to 2.6–7.5 years in the children’s hospital unit. Experience was defined as working for 5 years or more in the specific unit.

A total of 6727 estimates of intensity of care (PAONCIL) were scored by the nurses for their allocated patients for their shift. This linear scale has seven levels of intensity ranging from very low (–3) to optimal (0) to very high (+3). In the perinatal unit, 39% of the staff who were allocated more than one patient rated their intensity of care as high compared to 31% who were allocated one patient \( (P = 0.014) \). A similar pattern was seen in the children’s hospital unit where 46% with more than one patient compared to 33% with one patient \( (P \leq 0.001) \).

To identify workload measures that capture the patient’s acuity as well as the nurses’ ability to provide an optimal level of care, two methods were examined to arrive at an estimate for each nurse. The PDS tool was chosen as it provided the closest estimate of required nursing hours to the current staffing requirements. The PAONCIL was chosen as the second measure as it was scored by the individual nurse according to the level of intensity of care required by the number of allocated patients for the shift.

First, the total unit workload was calculated by adding the raw scores of the components of care as measured by the PDS for each of the three shifts. The workload per nurse was then calculated by dividing the total raw score by the number of nurses working in each shift. This gave an actual workload per nurse which was converted to hours of care required as estimated on the PDS. The hours required were an average of 12.12 for each nurse in each shift in the two units. The morning and evening shifts were 8 hours and the night shift 10 hours in each unit. The extra time was covered by additional support staff such as clinical managers, clinical educators and team leaders who often provided extra hands-on care and support for the front-line clinical nurses.

Secondly, the actual workload per nurse as estimated by the patient’s nursing needs was compared to the nurses’ professional assessment of the level of intensity of care required as measured on the PAONCIL (Table 2) using Pearson correlation. It was estimated that a demand for nursing hours of care would be associated with an increase in the intensity ratings by the individual nurses. The variability between shifts and the different workloads between units are shown. We did not take into consideration the experience of the individual nurses.

Infants who required a high level of nursing care as determined by the PDS (level 4) were cared for by experienced nurses 50–52% of the time in both units (Table 3).

In addition, a total of 3181 SNAP scores were obtained that indicated the severity of illness based on physiological indicators. When the SNAP scores were compared to the dependency measures there was a moderate relationship between daily serial SNAP scores.

### Table 1

<table>
<thead>
<tr>
<th></th>
<th>Estimated nursing hours</th>
<th>Actual nursing hours</th>
<th>Discrepancy in hours</th>
<th>Discrepancy as %</th>
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<tr>
<td>NNN-DT</td>
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<td></td>
</tr>
<tr>
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<td>111</td>
<td>195</td>
<td>–81</td>
<td>43</td>
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<tr>
<td>Children’s NICU</td>
<td>119</td>
<td>192</td>
<td>–73</td>
<td>38</td>
</tr>
<tr>
<td>PDS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>195</td>
<td>–10</td>
<td>5</td>
</tr>
<tr>
<td>Children’s NICU</td>
<td>215</td>
<td>192</td>
<td>+25</td>
<td>13</td>
</tr>
</tbody>
</table>

NNN-DT, Northern Neonatal Network-Dependency Tool; NICU, neonatal intensive care units; PDS, Patient Dependency Score.

### Table 2

<table>
<thead>
<tr>
<th></th>
<th>Perinatal NICU</th>
<th>Children’s NICU</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>( n )</td>
<td>( r )</td>
</tr>
<tr>
<td>Morning shift</td>
<td>153</td>
<td>0.173 &lt;0.05</td>
</tr>
<tr>
<td>Evening shift</td>
<td>153</td>
<td>0.321 &lt;0.001</td>
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<tr>
<td>Night shift</td>
<td>153</td>
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<tr>
<td>All shifts</td>
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<td>0.295 &lt;0.001</td>
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<table>
<thead>
<tr>
<th></th>
<th>Perinatal NICU</th>
<th>Children’s NICU</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( n )</td>
<td>( R )</td>
</tr>
<tr>
<td>Morning shift</td>
<td>152</td>
<td>0.310 &lt;0.001</td>
</tr>
<tr>
<td>Evening shift</td>
<td>153</td>
<td>0.210 &lt;0.001</td>
</tr>
<tr>
<td>Night shift</td>
<td>153</td>
<td>0.200 &lt;0.01</td>
</tr>
<tr>
<td>All shifts</td>
<td>458</td>
<td>0.249 &lt;0.001</td>
</tr>
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</table>

NICU, neonatal intensive care units.

### Table 3

<table>
<thead>
<tr>
<th></th>
<th>Perinatal NICU (%)</th>
<th>Children’s NICU (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 4 acuity</td>
<td>50</td>
<td>52</td>
</tr>
<tr>
<td>Level 3 acuity</td>
<td>38</td>
<td>33</td>
</tr>
<tr>
<td>Level 2 acuity</td>
<td>38</td>
<td>33</td>
</tr>
<tr>
<td>Level 1 acuity</td>
<td>42</td>
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NICU, neonatal intensive care units.
and NNN-DT average daily nursing hours required ($R^2 = 0.38$) and between daily serial SNAP scores and PDS average daily nursing hours required ($R^2 = 0.38$) in the children’s hospital unit with an automated system. There was no relationship between the SNAP and the average daily nursing hours with either tool when collected manually for three consecutive days and then every third day ($R^2 = 0.00$) in the perinatal unit.

By examining the intensity ratings across both units we were able to identify certain risk factors that contributed to an increased workload (Figure 1). Having less than 5 years of experience and the use of casual staff were risk factors with an adjusted odds ratio (OR) and 95% confidence intervals that were statistically significant.

Organizational factors that contributed to the workload as perceived by the nurses who indicated that their patients required a high intensity of care are shown in Figure 2. The significant factors are those where the 95% confidence interval does not cross one. The patterns are similar in both units with the most significant factors being the organization of the work of the manager or clinical manager and the shift schedule. Other factors of note are the mental stress and the nurses’ own ability. The same trend was seen in both NICUs.

### Limitations of the study

The limitation of the study was that the measure of the outcome of the nursing care was not included. If measuring workload alone is to have true meaning then the hours required and provided need to be considered in terms of the quality and outcomes of the nursing care provided.

### Discussion

Our study results demonstrated that measures of workload in two NICUs proved to be consistent and allowed for variances between the units to be acknowledged. Differences between the two units were evident in their case-mix which resulted in variations in occupancy, ventilated patients and the number and experience of the nurses currently employed. This variation makes it difficult to adopt measures of workload that considers specific categories of infants based on their underlying disease (Northern Neonatal Network 1993), severity of illness (Richardson et al. 1993) as scored by physiological measures and the need for specific interventions (Arthur & James 1994) when determining an appropriate measure for use in many NICUs.
Different methods for measuring nursing workload in the NICU were used in the study. The measures included the nursing care hours required as estimated by the nurses for their allocated patients (Northern Neonatal Network 1993; Soliman 1998) and a method of measuring the intensity of care provided (Fagerstrom & Rainio 1999). We found that the estimates of nursing hours using two patient acuity dependency measures (NNN-DT and PDS) did not match current practice. This may be due to the measures used relying on tasks, broad categories of care and numbers of patients, which can be restrictive when measuring nursing workload. The care required by sick infants and their families is complex and variable, and the infant’s behaviour can contribute to the workload of the nurses. This behaviour is difficult to capture with the acuity measures and, the amount of care required can be subjective according to the skills of the carers in supporting and consoling distressed infants. When several infants are allocated to one nurse during a shift the competing needs of different infants require time management skills. These hidden components of care are difficult to capture in measures using physiological determinants or specific tasks to determine workload.

The calculation of unit workload to determine the average number of nursing hours required in a day can be used to indicate the number of nurses required in each shift. This calculation enables managers to roster or acquire more staff if the demand exceeds the number available. However, this practice often considers the problem in terms of numbers of staff and not necessarily the expertise or skill required for the care of the infants in the NICU at a given time. We found the correlation between the required and available nursing resources for each shift varied over the day as well the pattern changed between the two NICUs. All shifts had a weak correlation which indicates a shortfall of the nurses required. In practice this shortfall is taken up by clinical educators, managers or sometimes by the use of relief staff. The effect on the patient care can mean that some things do not get done, for example components of care such as comfort, support and teaching parents. Therefore the use of unit workload measures could be useful. However, work practices, model of care and individual needs require to be considered as part of the workload.

The dependency tools used in the study where the hours of care are estimated do not take into account the skill of the nurses in matching the infant’s needs to the care provided. The low proportion of experienced nurses caring for infants with a high level of dependency was a concern. The need for experienced nurses to care for high acuity patients is an expectation for the consumers of neonatal intensive care. The higher overall percentages of experienced nurses providing care for patients with low-level acuity in the perinatal unit could be due to the practice of allocating patients of differing dependency to a more experienced nurse. Due to the nursery layout in the children’s hospital these patients are grouped together and are often cared for by less experienced nurses. To account for differences in practice and allocation of patients with different acuity, a measure of the nurse’s capabilities needs to be considered when measuring workload as increases in workload may be dependent on the skill of the nurse and the layout of the unit.

Inadequate staffing, both in numbers and expertise, has been found to rate high on a list of stressors for NICU nurses (Hueur et al. 1996) and shortages create concern about the adequacy of patient care (O’Brien-Pallas et al. 2001). Concern has been raised about the intensity of the workload contributing to the retention and recruitment of nurses in the NICU (Commentary 2002). Workload, not the number of nurses, was identified as the factor determining clinical outcomes in a study based on mortality in 54 NICUs (Tucker & UK Neonatal Staffing Study Group 2002). Our findings support these authors and we believe that the methods chosen to measure workload are more meaningful if some of these factors are acknowledged.

In an attempt to consider alternative ways of measuring workload we chose to use the method described by Fagerstrom et al. (2000) which enabled the nurses to indicate the intensity of the nursing care required by their patients. Although this measure is subjective it does take into account the individual capabilities perceived by the nurse providing the care. The work in a neonatal unit involves individual nurses and each is unique, a measure that can capture this ‘humanness’ of the workforce was deemed to have potential in this highly stressful environment.

Our findings showed that the nurses’ perception of the care required by the infants allocated for their shift had a poor correlation with the traditional dependency measures which estimate nursing hours. We believe this discrepancy may be due to the fact that one method measures tasks and activities whereas the other uses the individual nurse’s perception of their own capabilities. By using this method, individual nurses were able to have an input into the staffing requirements on a shift-by-shift basis. Staff assignments were also altered based on the changing needs of the infants and their families and the variations in skill-mix that occurred on a shift-by-shift basis could also be considered.
What the study has shown is that organizational factors in the neonatal unit may have a more powerful influence on nursing workload than the acuity of the patients assigned to individual nurses. The way the team works together and the organization of the managers has shown to increase the nurse’s workload. The nurses who identified that their allocated patients required a high level of intensity of care also indicated that the shift schedule and organization of the manager contributed to their workload. The work environment and conditions of employment are significant considerations in reducing the stressors associated with work (O’Brien-Pallas et al. 2004). Mark (2002) described how nurses perceive inadequate staffing and increased workload and this was often reflected by the size of the unit, the design and bed occupancy rates. All these factors may affect the performance of the nurses and influence their perceptions of adequate staffing and appropriate workloads.

Nurses’ mental stress and their capabilities needs to be explored further in relation to their experience, job satisfaction and retention rates. In our study, several factors were identified by nurses in both NICUs as contributing to their workload and intensity of care. A workload that is perceived to be excessive and unrelenting has been described as a major cause of stress (O’Brien-Pallas et al. 2004). This maybe due to the fact that nurses feel they cannot provide the level of care that their patient’s require. Opportunities for the nurses to have less stressful work periods and support strategies, such as support groups or a mentorship program can help alleviate some of these stressors.

Nursing work in the NICU is a complex undertaking with sick vulnerable infants who require vigilance and constant support. There has been a move away from protocol-based tasks to the one relating the infant’s care to their specific cues and developmental needs (Als & Gilkerson 1995). This practice acknowledges the individualized care required by sick infants and their families. This care is not measured by the physiological stability or specific tasks but rather the time taken to ensure the infant is supported during recovery from the interventions. In addition, the needs of the families in achieving parenting skills and emotional support are part of the nurse’s workday in the NICU. Family-centred care is one goal of nursing in the NICU. With this goal, the traditional measure of workload when using the patient’s physical needs alone is considered inappropriate.

We did not measure specific nurse-sensitive outcomes in our study; however, the use of mortality has been linked to workload in one adult intensive care unit (Tarnow-Mordi et al. 2000). Nurse staff levels were examined in a national study of 799 hospitals in the USA (Needleman et al. 2002) to see if there was an association with complications or mortality. They found no associations between increased staffing and the rate of in-hospital deaths; however, they concluded that the higher proportion of hours of care delivered by registered nurses was associated with better care for hospitalized patients. We attempted to measure mortality, however the number of deaths that occurred during the study were small (total of nine deaths [2.5%] in both hospitals). Therefore, it was seen as an irrelevant measure for our study. Whitman et al. (2002) found that lower staffing levels resulted in higher rates of adverse outcomes such as medication errors, pressure sores and central line infections. To determine if staffing levels are adequate in the NICU, measures of outcomes of care that are ‘nurse sensitive’ and both positive and adverse need to be developed. Without adequate measures of patient outcomes it will remain a difficult task to determine the appropriate staff level as well as the desired skill-mix level during active recruitment. Although beyond the scope of this study, we felt this is an important issue that needs to be addressed in future workload research.

In conclusion, our study has shown that measuring workload in NICUs of differing care mix can be achieved. However, when measuring nursing workload it is not sufficient to use patient acuity or severity of illness alone. Measurement of the nurse’s assessment of the intensity of care required and organizational factors may enrich future research into nursing workload.

References


