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Infection prevention and control among paramedics: A scoping review



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Background: Paramedics are exposed to many infectious diseases in their professional activities, leading to a high risk of transmitting infectious diseases to patients in out-of-hospital settings, possibly leading to health care associated infections in hospitals and the community. The COVID-19 pandemic highlighted the importance of infection prevention and control in health care and the role of paramedics in infection control is considered even more critical. Despite this, in many countries such as Australia, research into infection prevention and control research has mainly been focused on in-hospital health care professionals with limited out-of-hospital studies.

Methods: This scoping review was based upon Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines. Literature on knowledge and awareness of infection prevention and control in paramedics in Australia and other countries was evaluated.

Results: Based upon selection criteria applied, six papers were identified for inclusion in this review. In many studies, infection prevention and control was identified as being important, however compliance with hand hygiene practices was low and most studies highlighted the need for more education and training on infectious disease for paramedics.

Conclusion: Current evidence suggests that paramedics have poor compliance with recommended IPC practices. The profession needs to improve IPC education, training, and culture.

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BACKGROUND

Paramedics are exposed to many infectious diseases (IDs) in the out-of-hospital environment, such as the influenza, chicken pox, and coronavirus disease 2019 (COVID-19).^{1–3} Consequently, there may be a high risk of ID transmission between paramedics and patients in shared spaces, such as within ambulances, or patients' homes.⁴ Furthermore, IDs such as methicillin-resistant *Staphylococcus aureus* infections, influenza, and severe acute respiratory syndrome are

known to be transmitted to paramedics from patients, putting them at higher risk of infections compared with the general public.⁵

ID transmission can lead to health care-associated infections (HAIs), which negatively impact patients worldwide each year and have an additional significant financial burden on health systems. As part of an international focus on reducing HAIs, infection prevention and control (IPC) have become a center of attention in research.⁴ Historically much of the IPC research has understandably focused on in-hospital environments and acute-care facilities,^{6,7} however, an increasing body of IPC research is evident in out-of-hospital clinical environments^{8,9} and specifically within international paramedic environments.^{10–12} What remains unclear, however, is the extent of recently published IPC research in the Australian paramedic setting. This is of interest because Australia has some of the world's largest ambulance jurisdictions that are distributed across vastly diverse geographical (urban, coastal, rural,

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and remote) and socioeconomic communities¹³ where health outcomes can be disparate.¹⁴ IPC research within the Australian paramedic context may therefore have wider applicability to diverse international jurisdictions. The purpose of this scoping review is to identify and explicate the findings of IPC in paramedics with a focus on the Australian setting.

METHODS

This scoping review aims to evaluate the current literature on Australian paramedics' knowledge and awareness of IPC. This article followed the guidelines described by Levac et al¹⁵ and Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews Checklist.¹⁶

Inclusion and exclusion criteria

The search terms were kept broad as previous unpublished preliminary research found minimal Australian studies. Inclusion and exclusion criteria were used to refine the search for articles related to the review aim and to maintain time recency (Table 1). Articles were only included if published within the last 10 years to retain currency of literature. However, literature prior to 10 years was included, where relevant, in the discussion, for context.

Search strategy

A multidatabase search was used to find relevant literature addressing knowledge and awareness of IPC in Australian paramedics. These databases were EBSCOhost (health), PubMed, ProQuest, Science Direct, and Medline. Key search terms used were "Infection control," "Infectious disease," "Knowledge," "Awareness," "Australia," "Australian," "paramedic," "emergency medical technician," "emergency medical service," "pre-hospital," and "ambulance." Multiple phrases can be abbreviated to emergency medical services (EMS) and Emergency Medical Technician that could capture nonrelevant literature and the paramedic was truncated to further capture paramedicine. The term "paramedic" within the Australian context is defined as paramedics registered with the Australian Health Practitioner Regulation Agency. Paramedic registration has been required since 2018, prior to that the term paramedic may have been used more broadly, thus literature prior to 2018 could include differing participant demographics. The literature search was completed on April 26, 2023. Supplementary Table S1 was generated with all the combinations of search terms for each database.

Data abstraction

Articles were selected through a multistep screening process. Duplicates were removed by the Endnote internal comparison tool.¹⁷ Article titles and abstracts were screened for their relevance to the

research. Selected articles were read in full prior to inclusion in the review.

Data synthesis

The first author reviewed articles that were selected for inclusion in this review and generated the main themes that were then discussed with the co-authors and 3 broad themes were identified at the end of this process. These 3 themes, that is, hand hygiene (HH) is a concept, practice was the activity, and guidelines that inform practice, were considered distinct from each other and used to categorize the articles.

RESULTS

A total of 7,097 articles were identified in the initial search, however, only 6 were included following the final selection (Fig 1). Of the 6 articles included, 3 were quantitative, 2 were qualitative studies, and there was 1 mixed-method study. Each article's methods, data collection tool, results, and limitations are summarized in Table 2.

Hand hygiene

Two studies explored HH in the out-of-hospital setting in Australia. An international study²² looked at 4 countries (Finland, Sweden, Denmark, and Australia) and their compliance with HH in EMS. The author uses the term "provider" as a broader term to encompass both basic and advanced care out-of-hospital Health Care Practitioners (HCPs) that include Emergency Medical Technicians and paramedics. The authors observed providers of EMS in 3 areas: HH, glove behavior, and basic hygiene parameters. Internationally a total of 77 EMS providers were observed, with 1,344 HH indications recorded. They established that providers only had a 15% compliance of HH and 54% of glove use.²² Specifically looking at the Australian cohort of the study, the compliance was 6% regardless of HH indication in Australian providers, compared with Finland with 11%, Sweden with 13%, and Denmark with 24%. This comparison suggests that Australian providers have overall low HH compliance compared with those in some other countries.

A sequential mixed-methods study¹⁸ explored self-reported behaviors and perceptions of hand hygiene and gloving practices. The study used an online questionnaire consisting of 29 constructs and 211 items, and semistructured focus groups to further inform the researchers of current behaviors and practices. They had a total of 417 completed surveys and found that 74.8% were confident with their IPC practices. They also found that HH was a minor aspect of their training with 16% to 65.4% of participants receiving competency-based training for IPC within Australian ambulance services. Common among the focus group participants was the lack of competency-based training and poor access to HH equipment. Paramedics were able to recognize when HH was needed, however, self-reported frequency of HH moments was poor, especially when cannulating patients and prior to touching the patient or the surroundings. The author concluded that paramedics require substantial improvement of HH and gloving practices to reduce the transmission of IDs.¹⁸

Practice

A recent study explored Australian HCPs' knowledge, preparedness, and experiences of managing COVID-19. They conducted a cross-sectional study that involved the distribution of a survey to emergency nurses, emergency physicians, and paramedics through their professional colleges. The survey consisted of 45 questions, a combination of multiple-choice and free-text responses, and

Table 1
Inclusion and exclusion criteria

<i>Inclusion criteria</i>	
Population	Paramedics
Context	Contained stated objective relating to IPC in the out-of-hospital setting
Time	2013 to present
Type	Peer-reviewed studies
Methodology	Quantitative, qualitative, mixed methods, and reports
Language	English
<i>Exclusion criteria</i>	
Language	Non-English
Geography	Non-Australian setting
Type	Not peer-reviewed

IPC, infection prevention and control.

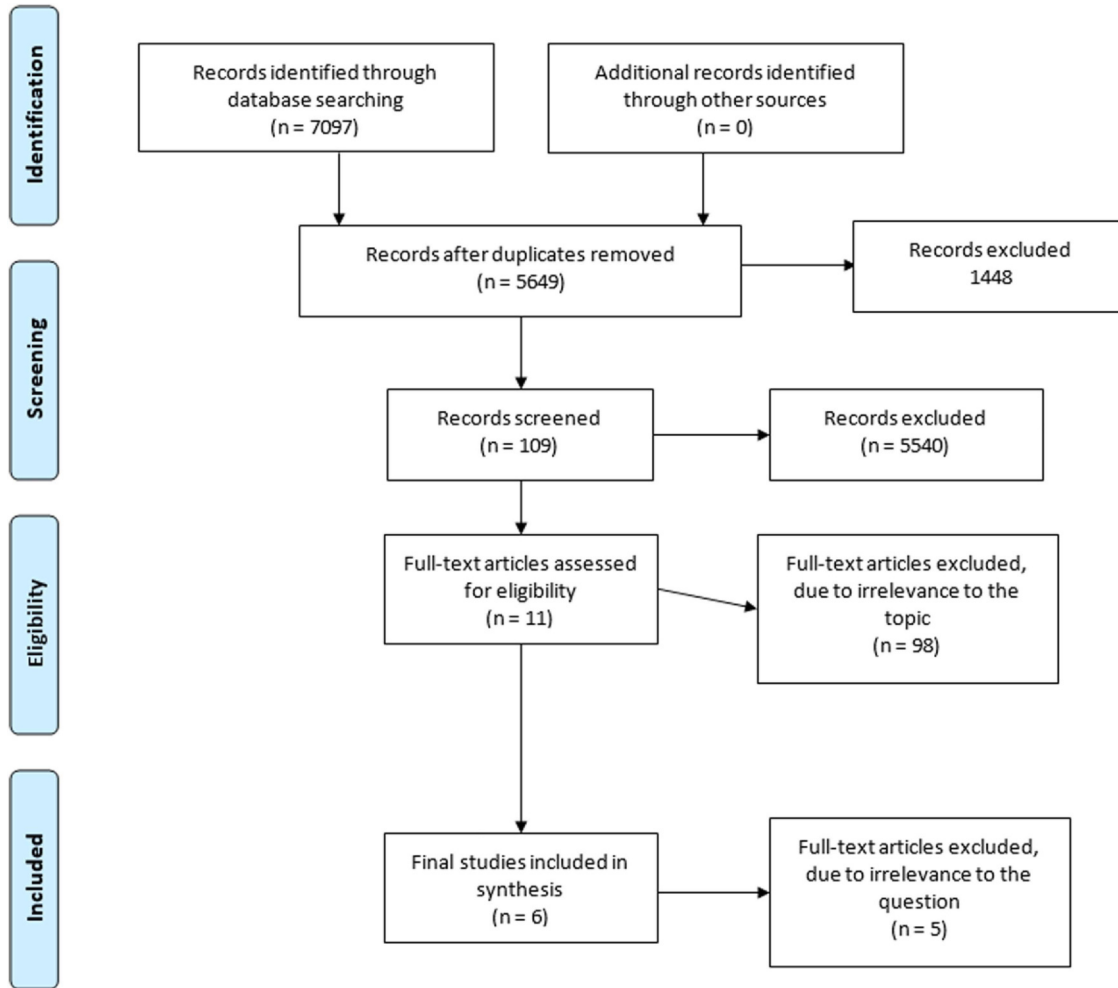


Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-Analysis: flowchart of the study identification and selection process.

contained 4 sections: demographics, knowledge of COVID-19, preparedness for COVID-19, and experiences working as an emergency clinician during the COVID-19 pandemic.¹ This review focussed on the responses of the paramedics surveyed in this study. They found 50% of paramedics self-reported their knowledge of COVID-19 as “good” and 29% reported it as “very good,” however, the authors did not test respondents on their knowledge. They also found the majority of paramedics received regular updates on COVID-19 from either the state health websites or employer emails.¹ Furthermore, the authors asked participants how easy it was to keep up-to-date with constantly evolving information regarding COVID-19 with paramedics’ top responses stated to be “very easy” and “easy.” Areas that were stated to be easy to stay up-to-date were “epidemiology,” “infection prevention and control measures,” and “use of PPE.”

Another article explored the challenges for environmental hygiene practices in Australian paramedic-led health care.¹⁹ They found that most participants agreed that cleaning an ambulance or shared equipment was part of their duties and that poor cleanliness increased the risk of transmission of HAIs. One-third of participants reported that they regularly worked in a patient compartment of an ambulance that was visibly dirty and some reported that blood contamination on equipment was common at the beginning of shift. It was also reported that recognizing appropriate methods of cleaning sequences of small or large spills was difficult. The 3 major barriers to performing routine cleaning activities were identified to

be operational pressure, lack of appropriate equipment, and workplace culture. Furthermore, participants’ employers did not prescribe deep cleaning schedules for ambulances.¹⁹

The study by Vikke et al²² suggested overuse of gloving in Australian paramedics with high rates of continuous gloving practice before patient contact and before aseptic procedures. Gloving practices were also explored by Barr et al¹⁸ who found that paramedics have high rates of continuous use of the same pair of gloves throughout each patient encounter. They also found that the same pair of gloves were worn when touching keyboards, radios, clinical bags, and during patient interactions.

Guidelines

Practice-specific guidelines are important for paramedics to have clear and relevant information regarding IPC. It has been suggested that paramedics have a limited understanding of IPC and poor compliance with IPC guidelines.²⁰ Barr et al²⁰ undertook a qualitative exploration of IPC guidelines of Australian ambulance services. Four of the 8 ambulance services provided their IPC operating procedures and were compared against the National Health and Medical Research Council (NHMRC) 2010 guidelines. They found that current ambulance guidelines were shorter in length and the level of detail differed from the NHMRC 2010 guidelines. Areas of limited advice were aseptic nontouch technique, governance and surveillance,

Table 2
Article methods, data collection tool, results, and limitations

Article	Author	Year	Method	Data collection tool	Results	Limitations
Self-reported behaviors and perceptions of Australian paramedics in relation to hand hygiene and gloving practices in paramedic-led health care	Barr, Holmes, Roiko, Dunn, and Lord ¹⁸	2017	Sequential mixed methods	Online questionnaire followed by semistructured interviews' focus groups	Perceptions of Australian paramedics in relation to the importance of HH and gloving during paramedic-led health care may not be transferring into clinical practice.	Misreporting of infection prevention practices due to social desirability. Self-selection bias with large dropout rate. Unable to be generalized to paramedic population.
Challenges for environmental hygiene practices in Australian paramedic-led health care: A brief report	Barr, Holmes, Roiko, Dunn, and Lord ¹⁹	2018	Qualitative	Online questionnaire	Poor compliance with the routine cleaning of shared medical equipment. Adequate understanding of the increased risk of health care-related infections with poor compliance.	The authors did not discuss the limitations of the article.
A qualitative exploration of infection prevention and control guidance for Australian paramedics	Barr, Holmes, Roiko, and Lord ²⁰	2017	Qualitative	Content analysis and semistructured interviews	Considerable differences in the IPC operating procedures by ambulance services and the National Health and Medical Research Council 2010 guidelines. Research is required to identify the key barriers and enablers to effective IPC practices in paramedicine.	Four Ambulance Services declined to provide infection prevention and control operating procedures. Dichotomous coding was used to compare coverage issues.
Collaborative, innovative quality improvement activity: Development of Queensland Ambulance Service Stickers: Drivers, approaches, implementation, and outcomes	Ding, Aitchison, Pink, Brown, and Tan ²¹	2019	Quantitative	Observational	Sticker application, mandatory peripheral intravenous cannulation (PIVC) documentation/communication, and patient education has led to a decrease in the number of Queensland Ambulance Service-inserted PIVC in situ patients on the ward.	The authors did not discuss the limitations of the article.
Emergency clinicians' knowledge, preparedness and experiences of managing COVID-19 during the 2020 global pandemic in Australian health care settings	Li, Sotomayor-Castillo, Nahidi, Kuznetsov, Considine, Curtis, Fry, Morgan, Walker, Burgess, Carver, Doyle, Tran, Varshney, and Shaban ¹	2021	Quantitative	Online questionnaire	Extensive specific training, education, and support lead to emergency clinicians in Australia who felt prepared to manage patients during COVID-19. However, significant challenges included inconsistent communication from management and availability of personal protective equipment.	Low response rate and scale reliability.
Compliance with hand hygiene in emergency medical services: An international observational study	Vikke, Vittinghus, Giebner, Kolmos, Smith, Castren, and Lindstrom ²²	2019	Quantitative	Prospective observational	HH amount EMS providers were remarkably low and higher after patient encounters compared with before patient encounters. Overreliance on gloves. Further research on contextual challenges and hygiene perceptions among emergency medical services.	Statistically significant results had been attained, the numbers reported are fairly low. Hawthorne effect and interobserver variation might be present.

COVID-19, coronavirus disease 2019; EMS, emergency medical services; HH, hand hygiene; IPC, infection prevention and control.

facility design, and staff health and safety. There was minimal consistency between Australian ambulance services with IPC guidelines and this may result from a lack of national guidelines to provide guidance and support to services. The authors recommended a national approach similar to the United Kingdom and the United States to have national IPC guidelines for their out-of-hospital providers.²⁰ A single EMS²¹ explored the implementation of a guideline-based intervention focusing on the out-of-hospital cannulations that have been inserted by paramedics. They developed a 3-pronged strategy to ensure that paramedic-inserted cannulas are to be removed within 24 hours of patient arrival at the hospital. The first strategy was uniquely identifying stickers with the letters “QAS-IVC” that were applied to all patients with paramedic-inserted cannulas. Second, was mandated documentation by the nursing staff of paramedic-inserted cannulas and to be checked at the time of handover. The third prong was increasing patient education with information communicated to patients about the signs of infection and phlebitis. The authors found that after the strategies were implemented, there were several positive outcomes, including no adverse incidents, increased awareness among hospital staff, documentation rates, and risk management.²¹

There were no articles identified in this review that specifically explored Australian paramedics’ knowledge and awareness of IPC within the last 10 years.

DISCUSSION

This review established that in relation to HH, paramedics have low compliance. This has been reported previously.^{17,22} As reported by Barr and colleagues, 74.8% of paramedics were found to be confident with their IPC practices, including HH, when paramedics self-report on their individual HH frequency, it was found to be low, especially before touching a patient, after touching patients’ surroundings, and before and after intravenous cannulation. This is supported by Vikke et al,²² who also found low compliance rates with paramedics both in Australia and overseas, with overall compliance at 15% compared with only 6% compliance among the Australian paramedic study participants. This suggests that Australian paramedics’ compliance with HH practices is somewhat lower than that of their counterparts in other countries.

Overall, compliance with HH practices appears to be an international issue.²³ A US study found that EMS providers have poor HH practices in all clinical situations, including invasive procedures. This also extends to equipment disinfection.²⁴ One study found that EMS providers failed to maintain appropriate HH and glove practice around patients, with minimal disinfection of reusable medical equipment.¹ A common theme expressed throughout articles in Australian and overseas studies is that there continues to be poor compliance with HH, despite efforts to focus attention on this issue by research.^{18,22–24} Many articles have stated that poor compliance may be due to poor education, placement of hand sanitization equipment, and staff culture surrounding HH.^{25–27} Further studies have explored challenges and barriers to HH compliance in the out-of-hospital setting,^{18,22,23} however, future research is needed in order to understand and address the barriers to increased HH compliance and subsequent lowering of HAIs.

Knowledge has been identified as an important factor in increasing HCPs’ compliance with IPC guidelines and can lead to a reduction in HAIs. Lack of knowledge of IPC has been related to worsened practitioner compliance with IPC practices, increased risk of transmission of IDs, and poorer IPC behaviors.^{28,29} Shaban et al,²⁸ who published the only study investigating Australian paramedics’ knowledge of IDs, concluded that paramedics generally have poor knowledge of the etiology and transmission of IDs. The questionnaire-based study reported less than 50% of respondents

correctly identified the etiology for 8 of the 25 diseases, with the article stating that for participants to be deemed to have adequate knowledge, they must answer 50% or more of the 25 diseases correctly.²⁸ As for transmission of diseases, more than 50% of participants could not correctly identify 15 of the 25 diseases. This article is the only published paper that has explored Australian paramedics’ knowledge of the etiology and transmission of diseases and recommended a review of education and infection control practices within the out-of-hospital setting.

A study conducted by the first author of this article explored Australian paramedics’ knowledge and awareness of IPC.³⁰ This study was based on published research by Shaban et al.²⁸ Thirty-nine participants were recruited through social media, professional bodies, and relevant University Alumni, 67% of respondents answered at least 8 of the 9 etiology questions correctly (Supplementary Table S2).³⁰ From the qualitative data that were obtained from the respondents, the majority stated that “risk” was a factor when determining why paramedics need more education and training on IDs. Many paramedics mentioned that they could put patients, other paramedics, and family members at risk of exposure to IDs in the out-of-hospital environment and similar findings have been reported by other authors.³¹ Risk seems to be a large motivator for many paramedics to base their need for education. The dissertation is an insight into the current knowledge and awareness of IPC among Australian paramedics, however, due to the small number of respondents, no strong conclusions can be made with these data.

A study conducted in Poland looked at HCPs, including paramedics, their behaviors, and attitudes toward bloodborne pathogens.³² They found that 15.8% of paramedics correctly answered all 5 questions compared with doctors (32.9%) and nurses (9.2%). The authors rated 54% of all HCPs as having good knowledge of IPC.³² They found that better knowledge did not influence all behaviors or attitudes of HCPs, but there was insufficient data to conclude as there are many factors that could influence it. Another study³³ explored Polish paramedics’ behaviors and concluded that paramedics have insufficient knowledge about bloodborne infections that caused negative behaviors with infected patients. They found it was explained by insufficient training courses provided by the employer and lack of time for self-education.³³ A study completed in 2015 in the United States reached similar conclusions that EMS providers had poor knowledge of drug-resistant bacteria that could lead to higher rates of HAI.³⁴

A common theme among articles exploring the knowledge and practice of paramedics is that there is poor knowledge of IDs, which is related to poor behaviors and attitudes. Furthermore, most articles recommended there needs to be a focus on training courses and education to improve paramedics’ knowledge and understanding of IDs. Based on articles published during and after the COVID-19 pandemic, there appears to be an increasing focus on the importance of IPC practices, knowledge, and attitudes in health care professionals.³⁵ Four studies conducted during the pandemic in Saudi Arabia, Korea, Iran, and Central India found that a large number of paramedics included in these studies had good knowledge of IPC, HH, and personal protective equipment,^{36–39} although the level of knowledge was lower when compared with some other health professionals such as nurses.³⁶ It is unclear if the increase in knowledge of IPC practices reported in these studies was as a result of working during a pandemic, as pre-COVID-19 pandemic data from these populations are not available. As stated in many other papers reviewed, the 4 studies also suggested continuing to improve education and training for paramedics around IDs and IPC.

A US study looked at determining training and education needs for high ID preparedness and response.⁴⁰ They found that EMS providers would benefit from up-to-date education and training on highly IDs. In addition, they found that EMS providers are concerned

with the lack of up-to-date ID training they receive from their employers, and resulted in the use of government websites to obtain up-to-date highly ID information. They concluded a need to focus on delivering national-based training and education for highly ID in the out-of-hospital environment was required. The use of a multi-delivery approach to training was suggested for greater impact and to enhance preparedness for a potential outbreak of highly IDs.

An Australian study found that to further support paramedics and ambulance services, there is a need for specific IPC guidelines designed for the out-of-hospital environment, and that there is a lack of consistent approach from ambulance services regarding operating procedures for IPC and practice.²⁰ The NHMRC in Australia has released the Australian Guidelines for Prevention and Control of Infection in Healthcare, however, this is nonspecific to the out-of-hospital setting and paramedics. Progress has recently been made in supporting Australian Ambulance services with the development of the National Safety and Quality Health Service Standards Guide for Ambulance Health Services by the Australian Commission on Safety and Quality in Health Care.⁴¹ Within the guide, there is the “Preventing and Controlling Infections Standard” that focuses on developing, implementing, and monitoring systems that prevent, manage, and control infections, and to achieve good health outcomes for patients. The standard is detailed with strategies and examples that could be used to implement into Ambulance Services. The greatest weakness of this guide is that it is voluntary for Ambulance Services to implement into their policies, procedures, and practice.

As discussed in the article by Ding et al,²¹ strong quality improvement initiatives can lead to positive clinical change, and reduced risks of harm to patients. It requires a holistic approach with multipronged strategies to target specific areas that want to be changed. There has been some focus on HH auditing and guidelines recently. The Australian Commission on Safety and Quality in Health Care has coordinated the National Hand Hygiene Initiative that regularly audits and collects data on participating hospitals' compliance with the Five Moments of HH. In total, 619 hospitals represent the latest audit November 2022 to March 2023 with the national benchmark for HH compliance at 80%. The latest audit showed Ambulance compliance rate at 72.3%, below the national benchmark and the lowest when compared with all other HCP groups. A limitation of these data is that it is only collected within the hospital setting and would be difficult to generalize these data across the out-of-hospital environment.⁴² However, it is only publicly accessible data that show paramedics' HH compliance rates in Australia. The Council of Ambulance Authorities has an annual campaign “Take Five for Hand Hygiene” with a focus on good HH and appropriate wearing of gloves. The Council has created Zone Posters adapted from the Five Moments of Hand Hygiene with a focus on the out-of-hospital environment. A video on Hand Hygiene Bad Practices has been created to represent the transmission of pathogens throughout patient care when treated by paramedics within a State Ambulance Service.⁴³

This review was designed to capture Australian-based articles that were published in the 5 major health journal databases and gray literature was not searched. This design was chosen as there is a paucity of research in the area of IPC in Australian paramedics and the aim was to gain a fundamental understanding of this topic. Although this article focused on Australian research, the discussion explored recent international research providing an international context.

Recommendations

Based on this review, significant gaps in understanding of the rates of transmission between paramedics and patients and confirmed diagnoses of HAI were identified. There is an urgent need

for the development of paramedic-specific guidelines for IPC that aim to reduce the barriers to appropriate compliance in Australia. There has been recent research both in Australia and internationally exploring barriers to IPC for paramedics, however, there is little novel research exploring strategies and education that directly improve compliance. There is a strong need for future collaboration between paramedicine and other HCPs to share and communicate ways to improve compliance and culture of IPC as well as more multidisciplinary research. While it would be good to see an international approach to this issue, it is unlikely that this can be achieved in the short term.

CONCLUSIONS

Based on this review, it is clear that there is an urgent need for further education and training of paramedics in IPC practices. In addition, there is clear evidence for more research into cultural behaviors and barriers in relation to IPC among paramedics.

APPENDIX A. SUPPLEMENTARY DATA

Supplementary data related to this article can be found at [doi:10.1016/j.ajic.2024.06.014](https://doi.org/10.1016/j.ajic.2024.06.014).

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