Paramedic knowledge of infection control principles and standards in an Australian emergency medical system (EMS)

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Abstract

Infection control is an essential component of health care. The literature generally suggests that most health professionals' knowledge of infection control principles and standards is poor or, at the very least, inadequate. There is a paucity of research examining paramedic knowledge of infection control principles and standards, particularly in the Australian pre-hospital context. The purpose of this study was to determine paramedic knowledge of standard infection control definitions and principles in an Australian emergency medical system (EMS).

A confidential and anonymous mail survey was distributed to all paramedics working in a State-wide Australian ambulance service (n=2274) A total of 1258 surveys were returned – a response rate of 55.3%. Only 46.2% (n=581) of the participants identified the correct components of the 'chain of infection'. Correct identification of the definition of 'nosocomial' was made by 27.9% (n=347) of participants. Less than one-fifth (17.2%, n=217) of participants identified 'standards and additional precautions' as the current system of infection control. Less than half (41.6%, n=523) of the sample correctly identified hand washing as the primary infection control strategy to prevent cross-infection.

This study suggests knowledge of fundamental principles and standards of infection control among paramedics is poor in this jurisdiction and recommends the introduction of comprehensive in-service education programmes in infection control. Further research is required to investigate if, and how, these results may be realised in practice.

Introduction

Infection control is an essential part of health care [1]. There is overwhelming evidence that supports the importance of infection control in the delivery of safe and quality health care, where the continued improvement of quality of care and provision of safe working environments are considered fundamental within Australian health care establishments [2,3]. Prevention of health-care associated infections (HCAI) is a priority for health establishments. Central to this is the development and implementation of effective infection control strategies for preventing the transmission of infections from person to person within health care establishments [2].

Review of infection control standards and practice has arisen because of changing epidemiology of disease, widening of the scope of practice of health care providers, and increased occupational risks associated with provision of health care nationally and internationally [4]. There is now an identified need to review paramedic infection control guidelines in response to the changing patient care practices in the pre-hospital setting and the emerging roles for paramedics [5,6].

The increasing influence of evidence-based infection control practice in nursing, medicine, dentistry, and other clinical disciplines has not been widely reported in paramedic practice. McCulloch [1] outlines that it is vital for health care personnel to understand the process of infection so that they know how to prevent the transmission

of infection, yet little research has been conducted examining infection control in the ambulance, paramedic, and pre-hospital care environment in Australia. Given the infancy of pre-hospital care as a health discipline, this is not surprising [7].

Literature review

A thorough literature review with key terms sourced from the *Index Medicus*, including 'paramedic', 'ambulance', 'emergency medical technician (EMT)', 'infection control', and 'knowledge' was conducted on electronic databases, including Cochrane, MEDLINE, CINAHL, ERIC and PsychINFO. Manual searches, including an analysis of clinical policies and procedures across all Australian and New Zealand ambulance authorities, were also performed. This review revealed a paucity of published work on paramedic knowledge of infection control principles and standards; the literature search located few studies that examined paramedic knowledge of infection control standards and principles specific to the Australian setting. The following review draws on related studies of health professional in other jurisdictions.

Paramedic and the emergency medical context

Few contemporary studies were found relating specifically to paramedic practice. Those that were located are largely US-specific and not do not focus on knowledge of standards, principles and definitions. In the US, some preliminary research into ambulance infection control practice was conducted in the early and late '80s [8-10].

These are, however, of little relevance to contemporary challenges in the Australian setting.

In a US study, Klein et al.[11] examined if hospital (nurses and physicians) and pre-hospital (paramedics) emergency personnel were able to identify a patient with a potentially communicable infectious disease and activate the respective disaster plan. Patients were moulaged to imitate smallpox infection. None of the paramedics determined the patients to be suffering from a communicable disease, much less smallpox, nor did they adopt any infection control measures required for such an infection. The study raised concerns about the ability of paramedics and other emergency medical personnel to detect a patient with a highly contagious disease and subsequently comply with infection control standards and principles.

Lateef et al.[12] examined the implementation of changes in policies (such as transportation), training and education for ambulance officers in Singapore in view of the international Severe Acute Respiratory Syndrome (SARS) outbreak. They argue for the importance of educational and psychological preparedness of the paramedics and pre-hospital care providers worldwide in this era of SARS.

A similar study was conducted by Ko et al.[13] who evaluated the use of emergency medical systems (EMS) during the outbreak of SARS and assessed the incidence of infection among EMTs. Using a prospective, observational study conducted in the EMS of Taipei, Taiwan, the study found that, during the outbreak of SARS, the overall EMS activity volume did not change significantly, but the non-SARS EMS activities decreased. Compared with the general population, EMS providers are at higher risk of contracting the SARS virus, regardless of the difference in perceived levels of risk. The study highlights the importance of contemporary knowledge of infection control principles and standards for EMS during transport patients.

Chapman and Clarke[14] examined the infection control measures instituted for breathing equipment by ambulance services in the UK and compared pre-hospital with in-hospital practice. A postal questionnaire of all training managers in UK ambulance services with telephone follow-up for non-respondents or part respondents was conducted. The study indicated that, while the question of infection control was certainly not neglected, there was little consistency in standards or content of policies for breathing equipment either across or within ambulance services. Such inconsistencies have ramifications for practice. They argued for a need for ambulance services to recognise the importance of having clear and consistent infection control policies in place, specifically in this case for breathing equipment, which should be at least equivalent to those employed in hospital settings.

As a component of a larger study, a recent published study[6, 15] examined paramedic knowledge of infectious disease aetiology and transmission in an Australian EMS. The study found that overall knowledge of aetiology and modes of transmission of 25 infectious diseases was poor.

Nursing, medicine and other health professions

The importance of health care personnel understanding the process of infection – so that they know how to prevent the transmission of infection – has been well documented[1, 2, 4]. Nurse and physician knowledge of infection control standards and principles has been the subject of considerable research internationally.

Gould[16] undertook a study to discover whether nurses with an understanding of the theoretical principles of microbiology knew more about the clinical aspects of infection control than those without. Results from the survey of 130 nurses, using clinical vignettes, suggested that most participants would not perform optimally in the everyday situations depicted, nor would they have sufficient knowledge of microbiology to understand the theoretical principles underpinning infection control. A related study was conducted by Horton[17], who examined the perceived importance of microbiological knowledge to nurses to ascertain whether this knowledge was present. This study suggested that, although microbiological knowledge is considered necessary for safe infection control practice, nurses' actual knowledge falls far short of the level required for 'informed' practice.

Brumpton et al.[18] examined staff awareness and compliance with infection control policies and procedures in an Australian long-term aged care setting from the perspective of health care staff. An anonymous survey of 199 staff indicated that the majority of respondents (98%) were aware of an infection control manual in their workplace, but nearly one-quarter (23.1%) reported never using the manual. They argue organisations need to provide ongoing staff education to enhance knowledge and compliance with procedures as well as to and minimise barriers to effective infection control practices.

Sax et al.[19] assessed health care workers' (HCW) knowledge of, and attitude toward, standard and isolation precautions. A confidential, self-administered questionnaire was administered to a random sample of 1500 nurses and 500 physicians in a large teaching hospital. Approximately one-quarter of the 1241 participants had previously participated in specific training regarding precautions against transmitting pathogens conducted by the infection control team. Despite a training effort targeting opinion leaders, knowledge of transmission precautions or pathogens, and therefore standard infection control principles and standards, remained insufficient.

Askarian et al.[20] also conducted a survey of 1048 HCWs at eight Iranian hospitals regarding knowledge, attitudes and practices related to isolation precautions. They found inadequate and below-acceptable standards of infection control knowledge and practices in 75% of participants. Similarly, Houang and Hurley[21] carried out an anonymous questionnaire to assess the extent to which hospital medical and nursing staff were familiar with the written policies and procedures of infection control and their intended course of action in situations where no formal policies were available. Nurses

(n=56) were significantly more familiar with all written policies and procedures than medical staff (n=19). They were also more likely to seek advice in situations where no written guidelines existed. Many hospital staff were uncertain about the practical details of policies and procedures for infection control. They argue that ways to educate and motivate staff to comply with infection control measures were urgently required.

Bennett and Mansell[22] undertook a survey to explore 543 community nurses' experience and practices of using universal precautions from one Welsh health authority. The majority of community nurses self-reported compliance with universal precautions, although a small number of nurses stated that they re-sheathed needles, inappropriately stored sharps containers, inadequately wore gloves, and experienced difficulties in hand washing. Stein *et al.*[23] conducted a similar survey of doctors' and nurses' knowledge, attitudes, and compliance with infection control guidelines in Birmingham teaching hospitals. Their findings indicate a need for education, monitoring, improved availability of resources, and disciplinary measures for poor compliance are necessary to improve infection control in hospitals, especially among doctors. Other related studies have been conducted of nurses[24-26] and have reached similar conclusions.

The studies under review consistently identified a lack of infection control knowledge and poor adherence to infection control principles by HCWs across settings. Although it is known that knowledge influences workplace practices, little attention has being given to either the knowledge level of paramedics or their practices. Paramedics face particular challenges in the delivery of care that have not been researched, particularly in the Australian setting. The present study aimed to examine paramedics' self-reported knowledge of infection control standards and principles in the Australian pre-hospital environment.

Method

As part of a larger study on infection control knowledge and reported practice, a mail survey was constructed in accordance with National Health and Medical Research Council (NHMRC)[4] Standards, State Health Department Infection Control Guidelines[27], and consultation with members of an Ambulance and Infection Control Expert Working Group (EWG). The survey consisted of questions grouped into three sections regarding demographic characteristics of participants (10 questions), knowledge of infection control (10 questions), and reported practices (10 questions). Four questions within the survey related specifically to knowledge of infection control standards and principles. The survey tool, information sheet and consent form were piloted with a convenience sample of 20 paramedics, which resulted in minor editorial changes to enhance clarity. Pilot data were excluded from the main data set. Ethical approval was obtained from the Griffith University Human Research Ethics Committee and the Commissioner of the participating ambulance service.

All staff that held clinical position or a position that directly affected clinical outcomes were eligible to participate. The survey was distributed to 2274 paramedics across 240 locations within the State accompanied with stamped, self-addressed envelopes and information sheets. Participants were asked to omit any identifying comments such as their name, address or work station.

Results

Four discrete areas of self-reported knowledge of infection control standards and principles were assessed. These included the participants' knowledge of the components of the 'chain of infection'[28], the definition of the term 'nosocomial', and the definitions of 'current system of infection control' and the 'primary infection control strategy'[4, 27]. Figure 1 provides a copy of the questions as they appeared in the survey.

Q13: Which of the following represents the 'chain of infection'? (Please circle only one)

A   Organism, host, time, open wound, temperature.

B   Exit portal, reservoir, entrance portal, susceptible host.

C   Organism, entry portal, exit portal, reservoir, transfer mode, susceptible host.

D   Temperature, humidity, atmospheric pressure, organism, host.

E   Don't know.

Q15: Which of the following reflects the current system for infection control as adopted by the National Health and Medical Research Council? (Please circle only one)

A   Universal Precautions.

B   Barrier nursing.

C   Standard & Additional Precautions.

D   Isolation.

E   Don't know.

Q17: How would you define the term 'Nosocomial'? (Please circle only one)

A   Abnormal cause of disease.

B   Type of bacteria.

C   Connecting band of tissue.

D   Hospital-acquired infection.

E   Don't know.

Q18: Which of the following represent the principal element of Standard Precautions that reduces the risk of cross infection? (Please circle only one)

A   Use of gloves.

B   Hand washing.

C   Barrier nursing.

D   Isolation techniques.

E   Don't know.

Figure 1. Survey questions.

A total of 1258 useable surveys were returned, representing a response rate of 55.3%. The average age of participants was 38.1 years and average length of ambulance service was 10.1 years. Data were entered – a sample audited for accuracy of data entry – and analysed using Statistical Package for the Social Sciences (SPSS®) software.

Knowledge

Q13: Definition of 'chain of infection'

Participants were asked to identify the correct components of the 'chain of infection [28]. Overall, 46.2% (n=369) of the sample of participants identified the correct response. Of the total, approximately one-fifth (20.4%, n=244) of participants reported a response of 'don't know'.

Q15: Definition of 'current system of infection control'

Participants were asked to select the correct current system of infection control [4, 27]. Less than one-fifth (17.2%, n=217) of participants identified the correct current system of infection control (Table 1). More than half the participants selected 'Universal Precautions' (58.7%, n=732).

Q17: Definition of the term 'nosocomial'

Participants were asked to identify the correct definition of the term 'nosocomial'[4, 27]. Less than one-third (27.9%, n=347) of participants identified the correct definition, with almost two-thirds (65.3%, n=812) of participants reporting a response of 'don't know'.

Q18: Principal element of 'standard precautions'

Less than half (41.6%, n=523) of the sample correctly identified hand washing as the primary infection control strategy to reduce the risk of cross-infection (Table 2). Use of gloves was reported by the most number of participants (43.6%, n=548) and 7.1% (n=5.6) of participants reported they did not know.

Discussion

The present study raises concerns about the knowledge paramedics have of standard infection control definitions and principles, and the translation or realisation of this into practice. The understanding of disease aetiology and modes of transmission are vital components in understanding disease epidemiology, and form two components of the concept widely recognised in infection control as the 'chain of infection'. This concept illustrates the manner in which infectious diseases remain endemic in populations and, from time to time, lead to epidemics and pandemics. Further, it underpins the rationale for the use of precautions taken for particular infections [1].

In this study, participants were asked to identify the correct components of the 'chain of infection' from a possibility of five different answers in true/false format. Only 29.3% of participants correctly identified the six correct components of the chain, with 20.4% reporting that they did not know. This result suggests paramedics in this study have a poor knowledge of the basic mechanism of infectious disease epidemiology that relates to cross-infection. McCulloch [1] argues that it is vital for HCWs to understand the process of infection so that they know how they can help prevent the transmission of infection.

The term 'nosocomial infection' – that which is hospital or health-care acquired – is central to the philosophy of infection control. While the term 'nosocomial' has traditionally applied to hospital-based settings, more contemporary terms such as 'health-care associated infection' exist that acknowledge other community HCWs such as paramedics as potential sources of cross-infection [28]. Participants were asked to identify the correct definition of the term 'nosocomial'. Less than one-third (27.9%) of participants identified the correct definition, with 65.3% reporting they did not know the correct response. This result suggests a lack of contemporary knowledge of the basic principles of infection control.

Table 1. Q15: Data regarding current system of infection control.

Response	Frequency	%
A Universal Precautions	732	58.2
B Barrier nursing	35	2.8
C Standard & Additional Precautions	217	17.2
D Isolation	47	3.7
E Don't know	216	17.2
Total	1247	99.1
Missing	11	0.9
Total	**1258**	**100.0**

Table 2. Q18: Data regarding the principal element of Standard Precautions.

Response	Frequency	%
A Use of gloves	548	43.6
B Hand washing	523	41.6
C Barrier nursing	59	4.7
D Isolation techniques	56	4.5
E Don't know	71	5.6
Total	1257	99.9
Missing	1	0.1
Total	**1258**	**100.0**

Currency of knowledge is critical to effective infection control education programmes [1]. Participants were asked what they considered was the principal element of infection control to reduce the risk of cross-infection. Less than half (41.6%) of the participants correct response – hand washing. A similar number of participants considered glove-use as the principal element, with very few (4%) reporting barrier nursing or isolation techniques. Five percent of participants reported they did not know the correct response.

The survey also assessed self-reported knowledge of the current system of infection control in Australia [4]. Less than one-fifth (17.4%) of participants correctly identified the current system of infection, being Standard and Additional Precautions. Over half (58.7%) the participants considered Universal Precautions as the current system of infection control. Some 17.3% of the sample reported they did not know what the current system was.

While these questions only assessed self-reported knowledge and not actual practice, the results suggest a lack of contemporaneous knowledge. Given that hand washing is widely postulated as the single most important technique to prevent cross-infection, and that knowledge of prevailing contemporary standards of infection control is fundamental to best practice, the implications of these finding for clinical practice are reason for concern.

Paramedics and other emergency service personnel are at high risk of occupational exposure because of the unpredictable nature of their work [6, 15, 29]. It is not possible to predict which patients may have a communicable disease in the emergency care environment. Education of paramedics about the fundamental principles of infection control and their contribution to the prevention of infection is vital to allow the safe and efficient management of patients outside the hospital [29].

To engender improvement in knowledge and practice, implementation of a comprehensive education programme is required for all staff. This is backed up by McCulloch [1] who argues that, for there to be improvement in infection control practice, all staff require education and must actively participate in the implementation of infection control policies. Ambulance infection control requires the development of education and practice standards that specifically focus on infection control in the pre-hospital paramedic context.

However, studies have suggested that education alone is not likely to change infection control knowledge and practices [30]. Sound infection control practice requires informed instruction and the education of HCWs of all grades in all disciplines. McCulloch [1] further argues that it is critical that staff acquire a solid understanding of the transmission of infection, the role all parties play in prevention, and the practice that will best achieve this. Importantly, infection control skills should be observed and minimum standards maintained, as with any basic clinical procedure, and not merely taught and practised [1].

Limitations

There are limitations associated with conducting an anonymous survey. Although a response rate of 55.3% is acceptable, it is possible that only paramedics most interested in their professional practice responded to the survey. Non-participants may differ from participants in their opinions. The results may also be limited to some extent by recall bias and the overestimation of compliance with infection control practice. Future studies should include independent observation of practice to enhance rigour.

The results in the present study should be considered with caution. It could be that participants may have under- or over-reported their knowledge of standard definitions and principles in the workplace. The conditions by which participants completed this survey are largely unknown, and it cannot be assumed that participants completed the surveys independently or otherwise. Moreover, additional information is required about the education and training of paramedics relevant to infection control to enable further research and development of intervention programmes to meet the particular needs of the pre-hospital work environment.

Conclusion

Lawrence and May [28] argue that community-based HCWs are faced with specific challenges in infection control that their colleagues in hospital-based settings do not experience. Paramedics are community HCWs. They routinely work in emergency environments and conditions characterised as high-risk, high-stake, and time-constrained. New infection control guidelines by the National Institute of Clinical Excellence [22, 31] acknowledge the challenges presented in the community setting and address some of the difficulties faced by community nurses, as do others [28]. Similar guidelines specific to paramedics that are ground in evidence and research in the Australian pre-hospital setting have not been forthcoming.

This study highlights the need for further research on national issues and a comprehensive review of infection control practices in the pre-hospital paramedic setting. Despite the well-documented importance of infection control in preventing cross-infection, the results of the present study suggest paramedic knowledge of standard definitions and principles are generally poor. Further research investigating the translation of knowledge into practice specific to this setting is required. Examination of the results of this study to determine if or how they are realised in practice is also warranted. The continual challenge for ambulance services and authorities is to address specific ever-increasing challenges in infection control, and to establish evidence-based practices that not only value-add to patient care, but protect both staff and patients from cross-infection.
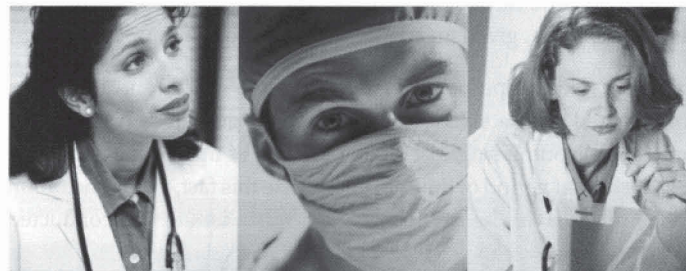
Acknowledgements

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