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## Issues of infection control in prehospital settings

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### Issues of infection control in prehospital settings

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#### Abstract

This paper considers infection control issues relevant to prehospital care providers. Specifically it examines practices related to the routine cleaning of patient monitoring cables between patients and, the cleaning and disinfection of respiratory equipment, in particular laryngoscope blades, facemasks and self-inflating resuscitation bags. The infection control issues are identified and an analysis of the operational, human resource and management practices relevant to these issues are discussed. Recommendations for best practice are explored.

#### Introduction

Changing patterns in health care practices over the past 50 years has seen a considerable expansion of the procedures performed by paramedics. Intravenous cannulation, parenteral injections, needle thoracentesis and endotracheal intubation are now common prehospital procedures. Due in part, to the nature of these procedures, paramedics are now placed at a much higher risk of exposure to potentially infectious fluids in environments that are often uncontrollable.

The primary objective of all health care organisations must be focused on the continuing improvement and delivery of quality health care by using effective infection control strategies that are based on preventing transmission of infection. One of the main requirements to meet this objective involves the development of written infection care policies that are capable of being implemented at every level within an organisation's hierarchy. This paper will examine the following two infection control issues:

1. The routine cleaning of patient monitoring cables between patient applications and,
2. The cleaning and disinfection of respiratory equipment, in particular, laryngoscope blades, facemasks and self-inflating resuscitation bags in relation to infection control issues and analyses of the operational, human resource and management practices relevant to the prehospital issues.

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### **The Basis for Infection Control**

Infection control is both an operational imperative and an occupational health and safety issue for all Australian Ambulance Services. Within Rural Ambulance Victoria, the infection control working party, a standing committee under the [Victorian] Occupational Health and Safety Act (1995), has been working towards resolving infection control issues across its span of control. It is reported that an infection control manual is being developed which will consolidate all infection control information into a single sourced document.<sup>1</sup>

In Queensland, infection control guidelines were identified in three documents:

- i. A stand-alone Infection Control Manual, which sets out procedures for environmental and waste management, sterilisation and processing of re-useable instruments and equipment, and the personal protection of paramedics. (Queensland Ambulance Service (QAS) 1997).<sup>2</sup>
- ii. An Appendix to the Service's Clinical Practice Guidelines, a manual which is available to all paramedics and contains a précis of the contents of the Infection Control Manual (QAS 2007).<sup>3</sup>
- iii. A chapter in the Services' General Administration Manual, the infection control philosophies stated that:

*"Infection control guidelines exist to assist officers ..... to determine the appropriate strategies necessary to reduce the risk of cross infection within the work environment."*<sup>4</sup>, pp 17-1 -17-5

The chapter from the General Administration Manual largely concerns itself with the minimisation of occupational exposure by individual health care workers and pre and post exposure procedures should an employee be at risk of contact with an infectious agent.

### **Administrative Issues**

Under the [Queensland] Workplace Health and Safety (WH&S) Act (1995), the Queensland Ambulance Service has established state and regional WH&S committees. These WH&S committees are considered the appropriate forum for the discussion of infection control matters. Under the [Victorian] Occupational Health and Safety Act (1995) there are directions for the joint participation of both employers and employees in determining safe and healthy working conditions in the workplace. The Victorian Act sets out two types of work place organisations:

- i. Health and Safety Representatives, who each represent the interests of a group of employees (ie designated work group), deal with management regarding day to day issues.
- ii. Health and Safety Committee, which concentrates on health and safety policies and procedures and issues covering the origination as a whole.

Although these workplace committees are concerned with the health and safety of employees, they are not directly concerned with infection exposure risks of the Service's client base *per se*. Protection of the client base is an important part of a proper infection control policy, and

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would be more appropriately overseen by infection control committees at state and regional levels. In Victoria, for example, infection control procedures are formulated under the auspices of the Health and Safety Committee structure<sup>4</sup>

### **Classification of Risk**

Infection Control Guidelines Steering Committee (ICGSC) of the Australian Department of Health and Ageing<sup>5, p.1-2</sup> have reported that successful infection control is based on the identification of hazards and the classification of risks and involves:

- i. Management practices that support infection control procedures and work practices.
- ii. Procedures and work practices that prevent transmission of infection.
- iii. An understanding of infection agents and means of disease transmission.
- iv. An understanding of specific factors that affect disease transmission in different health care settings.

Ambulance Service patients may contract an iatrogenic infection by:

- i. Exposure to infected blood / body fluids of other patients,
- ii. Exposure to infected blood / body fluids of health care workers,
- iii. Cross-contamination by previously infected equipment or fomites,
- iv. Contact with non-sterile or contaminated instruments during procedures.

Risk classification requires a suitable reference framework. One such framework was cited by the ICGSC (2004)<sup>5, pp. 16-5 - 16-6</sup> in which three categories; critical, semi-critical and non-critical are used to classify patient procedures and equipment:

- i. Critical procedures involve the entry of the subdermal or submucosal tissue, sterile body cavities or the vascular system. Instruments used present a high risk of infection if contaminated with microorganisms including bacterial spores, (i.e. the instruments must be sterile).
- ii. Semi-critical procedures involve contact with non-intact mucous membranes or skin. Instruments used must be free of all microorganisms with the exception of bacterial spores (i.e. obtain a high level of disinfection).
- iii. Non-critical procedures involve contact with intact skin but not mucous membranes. Instruments used must be cleaned from low to intermediate level of disinfection depending on the item and its use.

### **Patient Monitoring Cables**

#### **Situation:**

Paramedics routinely monitor patients' vital signs by the use of electronic devices, including pulse oximeters. The detector of a pulse oximeter is like a hollow peg that encloses the patient's digit when positioned for use. Since blood contamination of the inner surface of the probe is not obvious unless specifically looked for, that these probes are a potential source of patient-to-patient cross contamination. As a whole, these devices risk blood and other body fluid contamination during patient use, particularly when trauma is involved.

It is expected that grossly contaminated cables are routinely cleaned at the patient reception facility using a range of stock cleaning solutions at the end of each case. However in the absence of gross contamination, cable cleaning may be omitted due to either oversight or operational imperatives such as when another case requires the paramedics' immediate attention.

### **Risk Assessment, Hazard Identification and Characterisation**

The underlying principle of standard precautions is that all blood and body fluids are potential sources of infection. Human Immunodeficiency Virus, (HIV), Hepatitis B, (HBV), and Hepatitis C, (HCV), viruses are of particular concern. The risk of transmission of these viruses following accidental environmental exposure partly depends on their stability in the environment.

Hepatitis B virus appears to be more efficiently transmitted than HCV, which in turn is more efficiently transmitted than HIV.<sup>6</sup> At ambient temperatures studies have shown that HIV and HCV can survive for up to two weeks in the environment.<sup>7,8</sup> Hepatitis B virus has been demonstrated to survive in dried blood at room temperature for a week<sup>9</sup> and other studies have shown that HBV is very stable and able to survive for longer periods.<sup>10,11</sup> Cross contamination between patients is clearly possible when the internal surface of the probe is not cleaned adequately.

Personal observations indicated that routine post patient contact cleaning procedures vary widely amongst paramedics and vary from wiping with whatever cleaning agent is available at the patient reception facility to the use of alcohol wipes.

### **Assessment of Exposure Risk**

Australian Ambulance Services provide treatment and transport for a wide variety of patients, of whom paramedics routinely monitor oxygen saturation as part of their assessment of vital signs. Pulse oximetry monitoring is ideally a non-exposure prone and non-critical procedure. In trauma victims however, where compromised skin integrity is likely, the quick of the nail can provide a gutter for blood thus increasing the danger of probe contamination when it is applied to a digit.

### **Management of the Infection Control Risk**

There are two issues associated with the use of reusable pulse oximetry probes: firstly whether or not the probes are being effectively cleaned between each patient use; and secondly whether or not the cleaning techniques employed adequately disinfect the probes (and cables). Wilkins<sup>12</sup> found that standard cleaning techniques did not adequately disinfect reusable pulse oximetry probes that had been intentionally contaminated with high titres of pathogenic micro-organisms. Wilkins<sup>12</sup> also collected probes from 15 U.S. hospitals that had been terminally cleaned ready for patient use in accordance with each hospital's guidelines and then analysed the probes for bacterial but not viral contamination. Twenty-nine (66%) out of 44 'clean' probes cultured bacteria, 20 of which had been cleaned with alcohol or an antibacterial antiviral agent. Bacterial contamination was spread throughout 12 of the 15 hospitals sampled. Wilkins<sup>12</sup> concluded that none of the method used to disinfect the reusable probes had been effective.

Golder et al<sup>13</sup> found a high proportion of reusable hospital tourniquets were contaminated with blood and bacterial pathogens. In this study, half of the 50 tourniquets examined had visible bloodstains (and blood contamination was confirmed subsequently by laboratory analysis in all 25 samples) and all tourniquets grew heavy skin flora, 17 (34%) of the 50 tourniquets grew pathogenic bacteria.<sup>13</sup> While the study showed a substantial reservoir of potentially pathogenic bacteria on the reusable tourniquets, neither HIV-1 RNA or Hepatitis B surface antigen (HbsAg) were isolated from any of the tourniquets including the grossly blood stained ones. However since the time from collection of tourniquets to their subsequent analysis was not monitored the researchers warned that in areas of high HIV and HBV prevalence, there is still a potential risk of transmission from tourniquets to patient across areas of broken skin.

Proper risk management will ensure that patients and health care workers are not exposed to blood soiled probes. While Wilkins' study<sup>12</sup> has provided some doubt as to the effectiveness of cleaning methods for the decontamination of oximetry probes. The failure of Golder et al<sup>13</sup> to find live viruses on contaminated tourniquets indicated the need for local investigations into the contamination of pulse oximetry probes used by Australian Ambulance Services' to determine the extent of viral risk.

In the case of inadequate cleaning of probes (and cables) by paramedics, failure to achieve a benchmark standard of cleanliness may not stem from indifference or disregard by the paramedics themselves but more so from an organisational failure to identify the problem and educate the paramedic about the risks. Clearly there is a need to modify work practices.

In appropriately modifying work practices, Ambulance Services individually or collectively must first determine an appropriate cleaning technique and/or stock management. Furthermore Services must ensure suitable educational and material resources are available to ensure a high level of paramedic compliance.

## **Disinfection of Respiratory Equipment**

### **Situation**

Prehospital endotracheal intubations are frequently carried out in difficult situations; therefore it is common for the patients' oral and pharyngeal mucosa to be damaged during the procedure. In cases of trauma and cardiac arrest many patients have macroscopic blood in their airway on first inspection.<sup>14</sup>

Saliva, respiratory secretions, vomitus and blood routinely contaminate the laryngoscope blade, and other resuscitation equipment. In the Victorian Ambulance Services, all respiratory equipment is single use disposable, whereas the Queensland Ambulance Service practices terminal cleaning of respiratory equipment.

### **Risk Assessment, Hazard Identification and Characterisation**

Improper cleaning and sterilisation of respiratory items places a patient at great risk of cross contamination with blood and body fluid borne pathogens (both bacterial and viral). Several reports have documented the role of respiratory equipment as an important source of cross infection with micro-organisms causing respiratory disease.<sup>15,16</sup> *Pseudomonas aeruginosa* is

especially virulent and readily infects already compromised patients via the respiratory tract. *Mycobacterium tuberculosis* also readily infects lower airway critical sites.<sup>17, p. 118</sup>

Saliva and blood are known to transmit infectious diseases and the potential for transmission of infectious agents such as HIV and HBV via respiratory circuits and equipment has been identified over the past decade or so.<sup>15,18,19</sup> Laryngoscope blades and other reusable respiratory equipment must be terminally cleaned and sterilised prior to reuse if cross contamination is to be prevented.<sup>18,20</sup>

While the presence of blood is an indicator of potential cross infection, a number of studies have clearly identified occult blood contamination of laryngoscope blades. Morell and Crews<sup>21</sup> found that overall 10.5% of 'clean' laryngoscope blades were contaminated with occult blood, whereas in another study, of the 65 blades tested for occult blood 13 (20%) tested positive.<sup>22</sup> Interestingly laryngoscope handles had an even higher occult blood contamination rate with the cited studies reporting 50% and 40% contamination rates respectively, Roberts<sup>23</sup> has cultured numerous organisms from laryngoscopes which have been cleaned. The Victorian Ambulance Services have mitigated this risk by providing single use disposable laryngoscope blades, however the risk is not entirely eliminated because they continue to reuse handles.

### **Assessment of Exposure to Risk**

Only a small subgroup of prehospital patients are exposed to endotracheal intubation as part of their care. However these patients are generally the sickest and normally require longer hospital stays which involve intensive care admissions. Their risk of nosocomial infection is great due to their compromised physical status and it is essential that proper infection control measures are in place to protect them in both the prehospital and hospital environments.<sup>5</sup>

Endotracheal intubation is an exposure prone procedure because of the risk of damage to the mucosa and exposure to blood and other body fluids on contaminated instruments. Furthermore, according to the NHMRC Classification System it is a semi critical procedure, requiring that the reusable items involved (eg laryngoscope blades) should receive a minimum of high level of disinfection between patients.<sup>17</sup> Resuscitated patients are stressed by the circumstances of their condition and treatment, placing them at risk of infection.

### **Management of the Infection Control Risk**

There are two questions associated with the disinfection of reusable respiratory equipment, firstly is the equipment being effectively cleaned between each patient use and secondly, do the cleaning techniques employed adequately disinfect this equipment? As already stated semi-critical items should receive a minimum of high-level disinfection and if safe to do so such items should be sterilised.<sup>2,17</sup> Such methods would provide the highest level of assurance that the item is free from microorganisms.

Where items are reused they should be cleaned and dried as soon as possible after use and before disinfection procedures occur. Residual mucous, blood, tissue and other organic material interfere with the effectiveness of such procedures. Sterile single use disposable equipment optimises patient safety and minimises the cross-infection risk.

While laryngoscope blades and other respiratory equipment are intermediate risk items, they do come into close contact with mucous membranes and can therefore be contaminated with

virulent and readily transmissible organisms.<sup>17, p.118-19</sup> While Skilton<sup>24</sup> does not consider sterilisation as absolutely necessary, because spore bearing organisms are not a cause of respiratory infection, the ICGSC<sup>5, p.16-5</sup> recommends a minimum of high level disinfection.

Several studies<sup>21-23</sup> suggest procedures for cleaning; disinfection and sterilisation of laryngoscope blades and respiratory equipment are ineffective. The situation described here identifies unequivocally that poor compliance with infection control procedures was the source of the risk. Modifications of work practices are required in order to reduce the risk to patients.

At an organisation level an appropriate cleaning protocol must be established for respiratory equipment. Research findings<sup>15,24</sup> confirm the need for the institution of rigorous decontamination protocols to ensure the complete removal of blood and other organic material prior to sterilisation or disinfection. Laryngoscopes contain irregular surfaces that contain a number of crevices that are potential repositories for infectious material. Adequate preliminary cleaning is a critical control point that requires careful monitoring and if necessary corrective action to ensure an item free of soiling prior to the next step in the decontamination process.

## **Discussion**

Decontamination of patient care equipment requires the destruction or removal of any organisms present in order to prevent them infecting other patients and health care workers. Bacteria and viruses on equipment can gain access through skin lesions, inhalation of infected secretions or by close contact with damaged mucous membranes. The risks are as great in the prehospital environment as they are in the hospital setting. Terminal cleaning, disinfection and sterilisation are all part of the decontamination process. Decontamination reduces the risks of cross infection and has been shown to extend the useful life of many items.<sup>24</sup>

Studies have shown that blood borne pathogens (eg: HIV, HBV and HCV) are inactivated after being exposed to commonly used chemical disinfectants (NHMRC 2000).<sup>17</sup> Chemical disinfection eliminates many or all pathogenic microorganisms with the exception of bacterial spores from inanimate objects.<sup>5</sup> However effective disinfection is compromised by several factors:

- i. Organic load, which can deactivate active ingredients and provide a food source on which microorganisms subsequently thrive.
- ii. Type and level of microbial contamination, spores are resistant to chemical disinfection.
- iii. Physical make up of the object, for example, laryngoscope blades, have several curved surfaces containing crevices.
- iv. Concentration, temperature and pH of the disinfectant solution. These factors influence the exposure time to effect high levels of disinfection.
- v. Water quality may affect the effectiveness of a disinfectant when it is used as a solvent.

Chemical disinfectant can be divided into four main classes:

- i. Phenolic solutions (eg: Stercol and Hycolin) although effective against bacteria have limited activity against viruses.
- ii. Hypochlorites (eg. household bleach and Milton solution) have a wide range of activity against bacteria, fungi, viruses and bacterial spores, however are corrosive to metals, are inactivated by organic matter and have a limited bench life.

- iii. Alcohols (eg. ethanol and isopropanol) have good activity against bacteria and viruses provided all surface dirt has been removed. HIV and HBV are destroyed in 10 minutes when exposed to a 70% solution.<sup>24</sup>
- iv. Aldehydes (eg. glutaraldehyde and formaldehyde) are effective against bacteria, viruses and fungi but are irritating to the skin and eyes. To kill tubercle bacilli the exposure time must be prolonged, requiring greater than 60 minutes exposure to a 2% glutaraldehyde solution. HBV and HIV are inactivated by the same glutaraldehyde solution in one to two minutes although Skilton,<sup>24</sup> recommends thirty minutes exposure to ensure adequate penetration of solid items. Viruses causing rabies and haemorrhagic fevers are also killed by glutaraldehyde.

The importance of thorough cleaning of reusable items prior to further processing cannot be over stressed as improper cleaning protects micro-organisms from effective disinfection and sterilisation. Paramedics should have appropriate proficiency in proper cleaning techniques, furthermore appropriate personal protective equipment (gloves, goggles, aprons) must be worn during cleaning and disinfection procedures.

### **Conclusion**

Proper cleaning, disinfection and sterilisation are essential for protecting patients and paramedics from pathogenic microorganisms. This paper argues that to successfully control infection in the prehospital setting it is necessary to identify hazards, classify their risk and then to develop strategies to effectively manage the risks. An empowering infrastructure is imperative and management must provide leadership, information and resources to other stakeholders to ensure safe work practices and continuous quality improvement.

To achieve advancement in the area of infection control requires the development of a set of shared organisational values, behavioural guidelines and quality principles that support the Service's infection control strategy. Careful attention to this process will provide the safety that is needed when caring for patients.

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### **Additional Readings**

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