AN ASSESSMENT OF AMBULANCE INFECTION CONTROL IN AN EMERGENCY MEDICAL SERVICE IN THE ILEMBE DISTRICT OF KWAZULU-NATAL

By

SAGESHIN NAGURAN

STUDENT NUMBER: 18651193

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Durban University of Technology

Faculty of Health Science

Department of Emergency Medical Care and Rescue

Supervisor:----------
L.D. Grainger (PhD)

Co-Supervisor:----------
Y.M. Coovadia
(MBChB, FF PATH [Microbiology])

Date:----------

ABSTRACT

Purpose

The purpose of the study was to assess ambulance infection control in an emergency medical service in the Ilembe District of KwaZulu-Natal, by determining the prevalence of bacteria and fungi in ambulances, including those that are potentially pathogenic, and evaluating the knowledge and practices of staff in infection control.

Methodology

This quantitative, non experimental study used a cross-sectional, descriptive design to investigate aspects of ambulance infection control (IC). A laboratory analysis determined micro-organism contamination of ambulances, and a questionnaire was used to assess the ambulance IC knowledge and practices of 122 staff. All 15 ambulances in the district were checked.

Findings

Contamination of ambulances was widespread throughout the district under study, with 13 species of micro-organisms being identified, 10 of which were potentially pathogenic.

Many respondents were unaware of policies and procedures. IC knowledge, cleaning practices and procedures were generally poor, personal protective equipment was frequently unavailable and staff immunization was inadequate. Challenges were, insufficient time and cleaning resources. Patient body fluid exposures had occurred in 67 (54.9%) of the respondents.

Conclusions

Ambulances have an unacceptable level of pathogenic micro-organism contamination, and may be a reservoir in the transmission of potentially serious infections to patients and staff. There is a need for the development and implementation of evidence-based ambulance IC guidelines. These findings should be carefully considered and all attempts must be made to tackle the problem of ambulance cleanliness and infection control.

DECLARATION

The author hereby declares that the content of this research project is the author's own unaided original work, except where specific indication is given to the contrary (by reference). This work has not been previously submitted to the Durban University of Technology or any other University.

Signature: ----------

Date: ----------

DEDICATION

I would like to dedicate this work to:

- My mother Gonam and father Dr Frank Naguran, for their inspiration, love and gentle guidance.
- The emergency care practitioners of our country, whose service to the community is rarely acknowledged.

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CHAPTER ONE: INTRODUCTION

1.1. Background to the study

In prehospital emergency medical care in KwaZulu-Natal, split second decision-making in an often hostile environment, combined with high case loads and a fair amount of improvisation is the order of the day. In the author's experience as an operational paramedic, manager and educator, ambulance crews have limited cleaning equipment, and often, are too busy to return to the ambulance base to properly clean a contaminated vehicle. In some rural parts of KwaZulu-Natal, the ambulance may be 100 Km away from the nearest ambulance base or hospital. The ambulance staff members are expected to clean the vehicle as best as they can, often whilst calls are outstanding.

If such conditions are common occurrences, this could be a concern as the ambulance patient compartment has numerous surfaces that are easily contaminated and difficult to clean and disinfect effectively. In support of this, Jennings (2005) states that ambulances are potentially the weakest link in the fight against healthcare-associated infection. She further notes that ambulance cleanliness is a key factor in the battle against MRSA and other super bugs.

Although preserving the vital functions of a patient deserves top priority, hygienic protection of patients and ambulance staff are equally important. Victims of trauma, the immuno-compromised and the very old and young are transported daily by the ambulance services and if the vehicles are not adequately disinfected there is a danger that the very vehicles designed to save lives may be spreading disease. In addition, emergency medical services (EMS) staff, by the very nature of their profession, have a higher risk of exposure to pathogenic micro-organisms than most other health care professionals. Understandably, due to the nature of emergency care work, some reduction in infection control standards must be accepted, but ignoring some of the fundamental principles of infection control(IC) and prevention cannot be excused.

To prevent healthcare-associated infection (HCAI), specific guidelines for infection prevention and control need to be applied and monitored more rigorously and staff properly trained (Jennings, 2005). Education and training forms an important part of IC and prevention, and it is equally important that EMS management have mechanisms in place to monitor ambulance staff utilization of the knowledge gained, in their clinical practice. Yet, the researcher has not been able to locate any specific IC guidelines for the public sector EMS in KwaZulu-Natal, nor is there evidence of compliance monitoring and on-going education.

Studies on HCAI, and staff knowledge and practices in IC to date have been almost exclusively hospital based. Therefore, given the anecdotal evidence presented above, it is important to investigate whether the public sector ambulances are being properly cleaned. A key aspect of such an investigation would be to determine if and to what extent micro-organisms, particularly those that are potentially pathogenic, are present in the ambulances. In addition, an assessment of the IC knowledge and practices of ambulance staff should assist by providing information about what they know and do regarding the prevention of HCAIs.

1.2. Purpose of this study

The purpose of the study was to assess ambulance IC in an emergency medical service in the Ilembe District of KwaZulu-Natal by determining the types and levels of bacteria and fungi in ambulances, including those that are potentially pathogenic, and evaluating the knowledge and practices of staff in IC.

1.3. Objectives of the study

The first objective was to determine the types and levels of contamination of bacteria and fungi in ambulances including those that are potentially pathogenic.

The second objective was to evaluate the adequacy of the knowledge and practices of staff in ambulance IC. A survey, using a self report in the form of a questionnaire, was conducted to evaluate the knowledge and practices of staff in ambulance IC.

Based on the findings, the third objective was to establish whether there was a relationship between the types and levels of bacteria and fungi in the ambulances and the knowledge and practices of staff in ambulance IC. The explanation of these relationships is contained in Chapter Four, 4.4.

1.4. Research hypotheses

1.4.1. There is a difference between the sample sites within the ambulances and the types and levels of bacteria and fungi.

1.4.2. The types and levels of bacteria and fungi in the ambulances will differ at the different bases.

1.4.3. The knowledge and practices of staff in ambulance IC will differ at the different bases in the district.

1.4.4. The better the knowledge and practices of staff on ambulance decontamination the lower the types and levels of bacterial and fungal contamination of ambulances.

1.5. Null hypotheses

1.5.1. There is no difference between the sample sites within the ambulances and the types and levels of bacteria and fungi.

1.5.2. The types and levels of bacteria and fungi in the ambulances will not differ at the different bases.

1.5.3. The knowledge and practices of staff in ambulance IC will not differ at the different bases in the district.

1.5.4. There is no relationship between the knowledge and practices of staff on ambulance decontamination and the types and levels of bacterial and fungal contamination.

1.6. Motivation for the study

The researcher has always had an interest in microbiology, and has had some formal education in this field. Being a lecturer in emergency medical care, the researcher undertakes formal experiential learning with students, which entails working operational ambulance shifts. Feedback from students and colleagues, as well as casual observation has identified the critical need for research in the field of ambulance IC. Senior management from the ambulance service under study have expressed concern regarding the lack of proper infection control guidelines and the possible infection risk this may pose to patients and staff. This management has expressed it's willingness and full co-operation for the study. Findings of this study could serve as a motivation for possible implementation of a comprehensive IC programme specific for Emergency Medical Services in Kwa-Zulu Natal.

The second motivation was that the researcher has been unable to locate any published research studies that have investigated ambulance microbial contamination or the effectiveness of ambulance IC in South Africa. It is hoped that this baseline study will generate further research in the field of ambulance IC. Only three studies have been identified, two conducted in Europe and one in America, which demonstrated the presence of high levels of potentially pathogenic micro-organisms and inadequate decontamination.

The third motivation was the need for a similar study on South African ambulances, as it could indicate the potential infection hazard for ambulance

staff and patients, and could expose the possible role that the emergency medical services play in the spread of HCAI.

The fourth motivation is that an ambulance IC programme may be cost-effective in the long run, in that it may reduce HCAIs, thereby reducing hospital stay.

1.7. Assumptions of the study

Patients receiving emergency medical care have the right to an ambulance environment and staff practices that will not further compromise their condition as a result of a HCAI.

Ambulance staff members have the right to education and training, facilities and equipment and a safe and hygienic working environment in order to prevent and control the acquisition of occupationally-related infections.

1.8. Delimitations of the study

This study was conducted in the public sector EMS in one district in the province of KwaZulu-Natal and not in the private sector EMS industry.

Only ambulances were investigated in terms of the types and levels of contamination with bacteria and fungi. The types and levels of micro-organisms on environmental surfaces of other EMS work environments were not determined.

1.9. Operational definitions

The following definitions indicate how the key variables have been operationalized for the purposes of this study.

1.9.1. Types of bacteria and fungi

Specimens were cultured and organisms identified according to standard medical microbiology laboratory procedures. Only the following organisms were sought:

1. Coagulase Negative Staphylococci (*S.Epidermidis*)
2. Coagulase Positive Staphylococci (*S. Aureus)*
3. All *Streptococci*
4. coliforms – including *E. coli*, *Klebsiella* sp., *Proteus* and *Enterobacter* sp.
5. *Bacillus* sp.
6. *Diphtheroids* sp. and *Pseudomonas* sp. which were not identified further
7. Yeasts and other fungi

Extended spectrum beta-lactamase (ESBL) production was looked for in all the coliforms. Oxacillin was tested on all *Staphylococcus aureus* isolates to determine whether the isolate was sensitive or resistant to oxacillin (MRSA).

1.9.2. Levels of bacteria and fungi

A semi-quantitative enumeration of bacteria and fungi was obtained by measuring colony forming units.

1.9.3. Adequacy of knowledge and practice.

A structured questionnaire was used to collect data on the knowledge and practices of staff regarding ambulance IC. Questions included items on cleaning and self protection practices, and questions on demographics. This data was scored to determine the extent to which it was in keeping with accepted standards of IC.

1.10. Glossary of terms

1.10.1. Infection control programme

The establishment's oral or written policy and implementation of procedures relating to the control of infectious disease hazards. This includes identification of the infectious disease process and surveillance; preventing / controlling transmission of infection; programme management / communication; education and research and IC aspects of employee health.

1.10.2. Operational ambulance staff

Staff that work on ambulances providing advanced, intermediate or basic patient life support.

1.10.3. Emergency medical care

The provision of treatment to patients, including first aid, cardiopulmonary resuscitation, basic life support, advanced life support, and other medical procedures that occur prior to arrival at a hospital or other health-care facility.

1.10.4. Emergency Medical Services (EMS)

A group, department, or agency that is trained and equipped to respond in an organized manner to any emergency situation, where there is the potential need for the delivery of prehospital emergency medical care and / or transportation.

1.10.5. Ambulance infection control programme (AICP)

The implementation of policies and procedures to provide a safe and clean patient environment within ambulances, safe working conditions and best practices for all staff, in order to control infectious hazards. This includes prevention, identification and control of HCAI.

1.10.6. Advanced Life Support (ALS)

The provision of pre-hospital emergency care that paramedics are permitted to render, including advanced airway management, electrocardiography, external cardiac pacing, defibrillation, intravenous therapy and medication administration.

1.10.7. Intermediate Life Support (ILS)

Intermediate level of pre-hospital emergency care that includes basic life support, basic electrocardiography, intravenous fluid therapy, limited medication therapy, trauma care, and other authorized techniques and procedures.

1.10.8. Basic Life Support (BLS)

Prehospital emergency care provided by persons trained in first aid cardiopulmonary resuscitation, and other non-invasive care.

1.10.9. Healthcare-associated infection (HAI)

Infections that are acquired from within a health care setting. The infection was not present or incubating at the time that the patient entered the health care setting.

1.11. Structure of the dissertation

As was noted above, Chapter One introduces the study and includes a background to the study, the purpose, objectives, motivation, research hypotheses, assumptions, delimitations and definitions. The literature review that contextualizes the study is found in Chapter Two. Chapter Three addresses the study methodology with regards to design, study population, sampling, data collection, study challenges, data analysis and ethical issues. Chapter Four contains the results and discussion together, for each of the three study objectives, in order to avoid repetition. Finally, the conclusion and recommendations can be found in Chapter Five. References and appendices follow.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

In order to assess ambulance IC in an emergency medical service, the types and levels of bacteria and fungi was determined; and the knowledge and practices of staff members were evaluated. To achieve this, IC in the broader context needed to be examined. A literature search strategy is crucial in identifying previous bodies of knowledge in order to lay a foundation for the study. The following literature review will provide the background that contextualizes IC and prevention for the EMS setting. It also forms the conceptual framework for this study, which in turn has contributed to the methodology and discussion of the results. The review will be achieved by discussing the significance of IC; relevant microbiology; identification of micro-organisms including potential pathogens; and IC surveillance; and preventing / controlling the transmission of infectious agents. It will then focus on IC management / communication; education and research; knowledge and practice, compliance; and IC aspects of employee health. Finally, the importance of an IC programme and latest technologies in decontamination will be presented.

2.2. Literature search strategy

Searching and then reviewing the literature is an essential component of any study and is central to the research process. It is through the process of a systematic, explicit and reproducible literature review that the researcher may be able to identify a research problem and develop and refine a research question (de Vos et al., 2005). The researcher's interest is, therefore, not merely in literature, but in a body of accumulative scholarship. When reviewing a body of scholarship, Mouton (2001) states that the researcher is in fact interested in a whole range of research products that have been produced by other scholars. There are a number of reasons why a review of the existing literature is so important:

- to ensure that one does not merely duplicate a previous study;
- to discover what the most recent and authoritative theorising about the subject is;
- identifying relevant theoretical or conceptual frameworks for a research problem;
- to discover widely accepted definitions of key concepts in the field of study; and
- determining suitable designs and data collection methods for a study.

In this study, the literature search began in January 2007 and was ongoing until the end of February 2008. This was in order to keep track of the most recent research and information in the field of study.

A review of the literature was undertaken using the Durban University of Technology's library where subject headings and catalogues were searched. A thorough internet literature search was conducted on multiple databases using defined inclusion criteria to find studies with current and best evidence. The inclusion criteria for this review were the following:

- English language literature on the study subject, nationally and internationally. These included peer reviewed journals, accredited journals and information from centres of excellence example, Centre for Disease Control in Atlanta, USA and;
- literature, published or non-published, of relevance and appropriateness to the research questions.

Exclusion criteria related to the quality of the literature. Therefore, only scientific literature and referenced policy documents as opposed to popular magazines and newspapers were used. In addition, research reports and primary sources were preferred.

The search began by accessing the Cochrane Library 2004, Issue 2 and then progressing to the following databases: CINHAL, PROQUEST, PubMed and Science Direct. The Google search engine was utilized extensively.

The following key words and key word strings were used in these searches: ambulance infection control, hospital infection control, EMS infection control, paramedic infection control, infection control surveillance, ambulance nosocomial /healthcare-associated infection and infection control compliance were used. This provided a very extensive result with a large number of surveillance and compliance studies undertaken in the hospital setting. New references were identified through citations. There were disturbingly few studies conducted in the EMS setting. The abstracts of these and related articles, including their references were scanned to determine relevance. A point of saturation was reached when these same studies kept re-appearing as the literature search drew to a close.

2.3. The importance of infection control and prevention

2.3.1. The importance of infection control and prevention in general

HCAIs are infections that are acquired from within a health care setting (Galtelli, Deschamp and Rogers, 2006). Despite significant advances in our understanding and knowledge of the pathogenesis, prevention and control of HCAIs, these infections are still a significant public health problem throughout the world (Pearse, 1997). There are several reasons for this:

- The risk of acquiring HCAIs has increased through advances in medical technology and more aggressive approaches to patient management. Emergency care personnel have been recognized as professionals with an increase in their scope of practice which now includes many invasive therapies, for example needle thoracentesis, cricothyrodotomy, venous cut-downs, central venous IV therapy, retrograde intubation and umbilical vein catheterization. It is logical to conclude that a concomitant increase in the risk of HCAIs has accompanied this enlarged scope of practice.

- In many countries, particularly the developing ones, the indiscriminate and uncontrolled use of antibiotics has led to new resistant bacterial strains (Farr, 2000).This has impacted greatly on the cost of treatment. Frequently, this has been as a result of an unwarranted reliance on antibiotics by health professionals as opposed to the observance of basic IC principles (Farr, 2000).

- The rapid spread of human immunodeficiency virus (HIV) infection is a problem which affects patients, EMS staff and others who have contact with health care institutions. Recent statistics (Ilembe District Municipality, 2007) show that 30% of the population of Ilembe are HIV infected.

- From the author's own experience, inter-hospital transfers undertaken by the ambulance service include severely debilitated patients including ventilated neonates and patients being transferred to intensive care units. These patients could be further compromised as a result of acquiring infection from the ambulance environment.

Sound IC programmes lower the incidences of HCAIs (Damani, 2003). Well structured IC programmes play a vital role in reducing mortality, morbidity and costs to both the patients and health care system. Pittet (2005) states that IC surveillance remains one of the primary tools of prevention; it's impact needs to be more explicitly assessed. The primary objective of surveillance is to drive interventions that reduce infection rates, and control the spread of resistant micro-organisms and outbreaks. He further goes on to state that the active implementation of prevention strategies by IC programmes is essential.

2.3.2. Infection control and prevention in low and middle income countries

The importance of IC programmes are well acknowledged. This also holds true for developing countries. South Africa, with it's previously disadvantaged communities could be classed as one of them. Raza, Kazty, Mustafa and Gould (2004) state in their paper, that developing countries have their own characteristic problems with IC which differ markedly from those in the developed countries. It is important that both local and international authorities take these differences into account when formulating policies for use in developing countries. They emphasize the advantages of involving local experts in the development of such policies.

Zimmerman (2007) in her literature review to determine if current IC advice is applicable in low and middle income countries re-iterates the statements of the above study. She states that there is a need for the development of IC guidelines based on evidence but adapted to the specific needs of health care workers in third world countries. Low and middle income countries have utilised IC guidelines designed for first world countries, with varying degrees of success mainly because of physical, environmental, and socio-economic factors. She also emphasizes the advantage of involving local experts in the development of such policies.

2.4. The cost of infection

In an article by Stone, Braccia and Larson (2005) the total annual hospital-related financial burden of HCAIs in the United States was estimated to exceed $4.5 billion in 1992. Most of these infections were associated with the presence of an invasive device such as a central venous catheter or ventilator. Pittet (2005) states that HCAIs, whether acquired during home, ambulatory, institutional, or hospital care, constitute one of the greatest challenges of modern medicine. He states that according to the institute of medicine, hospital-related adverse events including nosocomial infections, in the United States represent a cost of $17 to $29 billion annually.

In the United Kingdom, hospital acquired infections cost around £1 billion a year and contribute to at least 5000 deaths. Importantly, these estimates only concern infections acquired in acute care hospitals and ignore those resulting from ambulatory care or acquired in other settings (Pittet, 2005).

In 1993 it was estimated that in South Africa, the cost of HCAIs was about R165 million for additional days of hospitalization alone. This was taking a conservative infection rate of 5%. If the infection rate is put at 15%, as reported from some developing countries, the cost could exceed R500 million. These wasted resources could be used more appropriately in other aspects of preventative health care (Pearse, 1997). This author has been unable to locate statistics revealing the financial burden, due to the lack of an IC programme, which the EMS industry has placed on the health care system in South Africa. However, given the financial constraints that are imposed upon the South African health care system, the effective prevention and control of infection makes economic sense.

2.5. The triad of communicable diseases

Introduction

The chain of transmission is a model that describes the components necessary for transmission of communicable diseases. The six links in the chain are the infectious agent, the reservoir, the portal of exit, the modes of transmission, portals of entry and the susceptible host (Emergency Health Services Branch, 2007). Incorporated into this is the host-agent-environment triad. This is an epidemiological model that is especially useful in understanding the causation of communicable diseases (Katezenellenbogen, Joubert and Abdool Karim, 1997). The triad of communicable diseases refers to the interwovenness of the host, organism and the environment in the causes, spreading and control (including prevention) of all communicable diseases. The host, environment and organism cannot be considered separately, as all three aspects have a collective role to play. By breaking up the links between the host, organism and the environment,

it is possible not only to prevent the disease but also, if an outbreak should occur, to implement the necessary control measures. Therefore attention must be continually given to all three of these aspects regarding IC and prevention (van den Berg and Viljoen, 2005). This section describes the three aspects and the manner in which they are related in the causation and control of infection, especially in the EMS setting.

2.5.1. The host

The host can be any living organism necessary for the micro-organisms to stay alive and multiply. The most common reservoir and source of micro-organisms in a clinical setting are patients themselves, particularly their excretions, secretions and skin lesions (Wilson, 2001). In this study setting, ambulance staff themselves, as well as patients could be the hosts. Factors related to the patient-host include age, social class, status and lifestyle (Katzenellenbogen et al., 1997). Hosts can either be healthy or sick.

The healthy host

A healthy host is a person who possesses a high natural state of immunity. This host has a general resistance which is the ability of the host to physically resist infection. It may be either an innate or an acquired ability relying on age, nutrition, hormones and the body's defence mechanisms. Immunity is the host's very high resistance against specific infective agents, which is either a natural or an acquired resistance (van den Berg and Viljoen, 2005).

In this study setting, the healthy host could be ambulance staff or "healthy" victims of trauma. According to the Emergency Health Services Branch (EHSB), (2007), ambulance staff members can reduce the risk of becoming a susceptible host by taking a number of measures to maintain natural defences. These include immunization, adequate nutrition, preservation of normal skin flora and intact skin, regular exercise, adequate rest and a reduction of stress levels.

The sick host

The person is infected and the disease is manifested either clinically or sub-clinically. Communicability is the ability of the sick host to transfer the disease to other hosts. The incubation period refers to the time from infection until the clinical manifestation of the condition. The host has the ability in this time period to spread the disease to other hosts (van den Berg and Viljoen, 2005). The severity of the disease depends on the susceptibility of the host.

The human carrier

Pathogens may not be normal commensals of the host, but still inhabit part of the body without causing adverse effects. This is described as colonization, and the colonized individual is called a carrier (Wilson, 2001). An example would be ambulance personnel spreading antibiotic-resistant bacteria to other staff and patients (Roline, Crumpecker and Dunn, 2007).

The contact

A contact is a person who has been in contact with a sick or infected person, or exposed to a contaminated environment or objects. A susceptible contact is someone who has never contracted the disease before, whose immunization against the particular disease was not successful or became lowered over a period of time, or whose general resistance is low (van den Berg and Viljoen, 2005). The immuno-compromised have general low resistance. In this study district of Ilembe, 30% of the population is HIV infected (Ilembe District Municipality, 2007). This means that one in every three patients transported by an ambulance could be a susceptible contact. .

2.5.2. The infective agent

Some micro-organisms are non-pathogenic by nature and form part of the normal flora of humans, referred to as commensals. Others are pathogenic and cause sickness on gaining entrance to the human body. The most important characteristics of infective agents are as follows (van den Berg and Viljoen, 2005; Wilson, 2001):

- Pathogenicity and virulence

  Pathogenicity refers to the ability of the infective agent to cause a specific clinical reaction after infection. It does not refer to the severity of the reaction. Microbes express their pathogenicity by means of their virulence, a term which refers to the degree of pathogenicity of the microbe. Virulence, a term often used interchangeably with pathogenicity, refers to the degree of pathology caused by the organism. The extent of the virulence is usually correlated with the ability of the pathogen to multiply within the host. In summary, an organism (species or strain) is defined as being pathogenic (or not), and depending upon conditions, may exhibit different levels of virulence.

- Infectivity

  The smallest number of micro-organisms necessary to cause an infection in a host. High infectivity is not necessarily associated with the severity of the disease. For example, the virus of *varicella* is considered extremely infective, although the disease is self-limiting with few complications.

- Invasiveness

  This is the ability of the micro-organism to spread within the host.

- Host-micro-organism interaction and penetrability

  Host-micro-organism interaction is the ability of the organism to enter tissues and to either bond with tissue cells or destroy them. In order to

cause infection in the body, a micro-organism has to gain access to and bind with appropriate cells. This is referred to as penetrability.

- Mutation

  Lewis (1995) states that mutation is the ability of an organism to change its genetic composition, thereby producing a modified form of the disease. Any population of organisms, bacteria included, naturally includes variants with unusual traits - in this case, the ability to withstand an antibiotic's attack on a microbe. Lewis goes on to state that when a person takes an antibiotic, the drug kills the defenceless bacteria, leaving behind or "selecting," in biological terms, those that can resist it. These renegade bacteria then multiply, increasing their numbers a millionfold in a day, becoming the predominant micro-organism.

- Mode of transmission

  Micro-organisms are transmitted directly by touching contaminated body parts or direct exposure to body secretions such as urine and body fluids such as blood and serum. They are also indirectly transmitted by fomites, contaminated food and water; and by air through droplets/aerosols and dust. Small particles may remain airborne for several hours and microbes carried on them may be inhaled into the respiratory tract or settle into wounds.

- Portal of entry

  Micro-organisms enter the body by several routes, namely via inhalation, orally, skin or mucosal inoculation, migration through the placental barrier and transfusion of contaminated blood or plasma.

- Route of exit

  Micro-organisms leave the body in various ways: infected stools, contaminated urine and skin lesions; via the mouth and nose; and by

blood leaving the body, an example being traumatic haemorrhage of an HIV infected patient.

- Carriers (non-human)
  Micro-organisms can be spread by various substances which can be classified as passive and active carriers. Passive carriers include air and dust particles. Active carriers include fomites, contaminated hands and infected body fluids and body excretions. Ambulances may have a significant degree of MRSA contamination and may represent an important active carrier in the transmission of potentially serious infections to patients (Roline, Crumpecker and Dunn, 2007).

The third part of the triad of communicable diseases is the environment.

2.5.3. The environment

Environmental conditions have a very important effect on the growth of micro-organisms. The environment includes the socio-cultural-economic environment as well as the physical environment.

Physical environment

Pathogenic bacteria grow most rapidly under environmental conditions similar to those of the human body (Wilson, 2001). Water is essential for the growth of micro-organisms and most die rapidly in its absence. Gram-negative bacteria in particular thrive in damp places. They are particularly vulnerable to desiccation and are viable only for a short time on dry surfaces. Other bacteria, such as *Staphylococci* and *Mycobacteria*, are more resistant to drying and some like *Clostridium difficile* are able to form spores (Wilson, 2001). Most spores are resistant to standard decontamination procedures.

Bacteria use either respiration, fermentation or both for energy production, changing the method according to the prevailing environmental conditions. These

are called facultative anaerobes and include enteric bacteria and the *Staphylococci*. *Pseudomonas* and *Mycobacteria* are examples of obligate aerobes that use only respiration and therefore cannot survive without oxygen. Conversely, anaerobic bacteria do not require oxygen. However, these bacteria can cause severe infection in wounds involving severe tissue damage or ischaemia (Wilson, 2001). These types of wounds are often seen in victims of trauma, being transported by ambulance.

Most bacteria grow within a wide range of temperatures and those that are pathogenic multiply rapidly at around body temperature. In general, bacteria cannot maintain a neutral pH if the concentration of hydrogen ions outside the cell is too high or too low, and prefer to live in approximately neutral environments (Wilson, 2001).

According to Wilson (2001), fungi can survive in relatively little moisture and in high osmolarity and are often found growing in environments that do not support bacteria. In susceptible patients, they cause superficial infection of the skin, oral and vaginal candidiasis, and more serious systemic infections in the immuno-compromised (e.g. aspergillosis).

Certain diseases are seasonal, such as measles and chickenpox. Climate changes, such as a decrease or an increase in humidity and extreme meteorological temperature changes, as well as smoke and air pollution can influence the resistance of the mucosa in the respiratory tract. Contamination of water and food sources and a lack of sanitation facilities can contribute to the growth and spread of micro-organisms. In the EMS setting, the small amount of space in the back of an ambulance means that subsequent patients occupy exactly the same area. This may increase the risk of disease transmission via the environment.

Socio-cultural-economic environment

The high density population in urban areas can contribute to closer contact between people. Poverty often goes hand in hand with urbanization and can contribute to poor housing which leads to poor environmental hygiene. These are contributing factors in the spread of disease.

Ambulance staff members' knowledge, attitudes and compliance with acceptable IC practices, together with the social customs related to living habits (spitting, coughing, sexual habits) of the patient population, their interpersonal behaviour and attitudes, and poor environmental hygiene can all contribute to infection transmission (van den Berg and Viljoen, 2005).

2.5.4. The host-agent-environment relationship

The relationship between host, agent and environment is of the utmost importance in the prevention and control of infection in the EMS setting since the degree of overlap of the three components of the triad can determine disease transmission (van den Berg and Viljoen, 2005).

The unpredictable nature of the environment and exposures encountered by ambulance staff can combine to result in occupationally acquired infections. For example, poor lighting at a road accident scene or in a collapsed mine shaft (environment) may limit the ambulance staff members' ability to detect blood, vomitus or faeces (carriers of pathogenic agents) of the patients (hosts) that they are treating (USFA, 2002). Some pathogens can cause a wide variety of infections; for example *Staphylococcus aureus* found in the environment, can infect the skin, but can also cause osteomyelitis, pneumonia and gastroenteritis (Wilson, 2001). Typically, patients in need of rapid care and transport to hospital may not have a definitive diagnosis, their history may not be complete, and most importantly, they may be hosts to an infective agent.

2.6. Infection control programmes

IC aims to prevent, identify and control infections within a health care facility (Pearse, 1997). Knowledge of potential sources of micro-organisms and an understanding of how they spread and who may be susceptible to them enables appropriate measures to be taken to prevent transmission of infection (Wilson, 2001). A generic IC programme consists of the following tasks: identification of infectious disease processes and surveillance / epidemiologic investigation; preventing / controlling transmission of infectious agents; programme management / communication; education and research; and IC aspects of employee health (Goldrick, (2005).

2.7. Ambulance infection control programmes (AICPs)

Although much research has been conducted on IC within hospitals, there is little in the literature regarding spread of infection within EMS in general and ambulances in particular. There are a handful of international studies related to ambulance IC. To the researcher's knowledge, only three studies, (Nigam and Cutter, 2003; Deschamp and Rogers, 2006; and Roline, Crumpecker and Dunn, 2007) have been identified, that partly meet the aim of this study. However, none of these studies provide evidence-based reasons for the prevalence of potentially pathogenic bacteria and fungi in this setting. This author could not locate any published research on ambulance IC in the South African context, hence the need for this type of research.

Although the researcher could not locate any specific, published guidelines for IC within South African emergency services, the Regulations for Hazardous Biological Agents, gazetted in terms of the Department of Labour's Occupational Health and Safety Act. No. 85 of 1993, are relevant (South Africa, 2001). This is a regulation that can be applied to every employer and self-employed person at a workplace where hazardous biological agents (HBAs) are deliberately produced, processed, used, handled, stored or transported; or where it may result in persons being exposed to HBAs in the performance of his or her work. Therefore,

these regulations are generic so that they can be applied in a range of settings. Although they are aimed at safeguarding workers, adherence to them will also protect patients from HCAI's.

The regulations deal with the following aspects:

- measures to be taken by the employer to protect an employee against any risk of being exposed;
- good housekeeping at the workplace and personal hygiene requirements;
- precautions to be taken by an employee for protection against the health risks associated with exposure;
- correct use, maintenance of safety equipment, facilities and engineering control measures provided;
- medical surveillance;
- work procedures regarding the use, handling, storage, labelling, and disposal of HBA at the workplace;
- procedures to be followed in the event of exposure, spillage, leakage or injury and;
- the potential detrimental effect of exposure on the human reproductive system.

Broad ambulance IC programmes (AICPs) have been developed in other countries (Ambulance Services Association (ASA), 2004; United States Fire Administration (USFA), 2002). These in turn, have been used by ambulance services for the development of their local policies and procedures. In respect of emergency medical services (EMS), the United States Fire Administration (USFA) stated in 2002 that a formal IC programme for this setting has two basic goals: (1) to provide all members with the best possible protection from communicable disease; and (2) to protect patients from potential infection. The document further states that a properly designed IC programme will help reduce the risk of members contracting a communicable disease, manage civil liability, lower health insurance costs, minimize “sick time” and ensure compliance with all

applicable statutes. The guide is designed as a resource to help emergency resource organizations tailor the requirements identified in regulations and standards to their own unique situations. The guide consists of the following:

- an overview of IC;
- components of an IC programme;
- vehicles, equipment, and supply considerations;
- facilities considerations;
- assessing effectiveness, the evaluation process and;
- special situations.

In the United Kingdom, the Ambulance Service Association (ASA), 2004) provides national guidance and procedures for infection prevention and control that consists of the following:

- microbiology and cause of infection;
- occupational health;
- standard principles of infection prevention and control;
- personal protective equipment;
- management of sharps, linen and waste;
- cleaning and decontamination;
- care of the deceased;
- care of infected patients and control of infestations;
- some specific communicable diseases and;
- biological warfare.

In addition to the broad guidelines for AICPs, there are more specific guidelines to prevent and control particular infections. Examples of these are the World Health Organisation guidelines against avian flu (World Health Organization, 2007).

A generic ambulance IC programme (AICP) will now be described, drawing principally from the ASA (2004) and the USFA (2002) guidelines, although other sources will be used. The details have been organized under the components of the IC programme outlined by Goldrick (2005) and referred to in Chapter Two, 2.6. This will form a framework for describing and assessing ambulance IC in the emergency medical services, which is the setting for this study. In particular, the framework will be used to gather literature on the primary aim of the study, which is the investigation of the presence of bacteria and fungi in ambulances and the evaluation of the knowledge and practices of staff in IC. The literature will indicate the standards to be complied with.

2.8. Surveillance in infection control and identification of infectious disease processes.

Surveillance is a monitoring system essential for the identification, prevention and control of infections. It is particularly concerned with the detection and identification of emerging pathogens, especially ones that are potentially dangerous and ones that are multiple drug-resistant (Pearse, 1997). Farr (2000) in his article, states that hospitals experiencing success in getting compliance from clinicians with IC guidelines, have generally retained an IC team that is deeply involved in surveillance and control activities. They continually respond to the challenge to educate and motivate clinicians to know and do the right thing.

It is important to note that the most common nosocomial pathogens may survive on surfaces for months and can thereby be a continuous source of transmission, if no regular preventive surface disinfection is performed. The longer a pathogen persists on a surface, the longer it may be a source of transmission and thus endanger a susceptible patient or healthcare worker (Kramer, Schwebke,and Kampf, 2006).

The Regulations for Hazardous Biological Agents (HBAs) (South Africa, 2001) have classified bacteria and fungi into groups, based on their potential to produce infection and subsequent toxic effects. They are as follows:

- group 1 are HBAs that are unlikely to cause human disease;
- group 2 are HBAs that may cause human disease and be a hazard to exposed persons, which is unlikely to spread to the community and for which effective prophylaxis and treatment is usually available;
- group 3 are HBAs that may cause severe human disease, which presents a serious hazard to exposed persons and which may present a risk of spreading to the community, but for which effective prophylaxis and treatment is available and;
- group 4 are HBAs that cause severe human disease, are a serious hazard to exposed persons and which may present a risk of spreading to the community, but for which no effective prophylaxis and treatment is available.

The viruses of concern to ambulance staff are the HIV and the hepatitis viruses which are usually transmitted in infected body fluids via a percutaneous injury, contact with mucous membrane or contact with non-intact skin (Centre for Disease Control, 2001). HIV transmission is via contact with body fluids of an infected person notably the blood, semen or vaginal fluids. Hepatitis A is present in the stool of infected persons, so transmission is via the faecal-oral route. The virus may also be contracted from eating contaminated food. The virus may be present in stools for up to two weeks prior to any symptoms. There are no special precautions required by staff, other than observing standard principles of IC. The Hepatitis B virus is found in all body fluids of an infected person; and can be transmitted by injection or puncture of the skin, contact with blood or body fluids via open cuts, sores and mucous membranes. Hepatitis C is a parenterally transmitted virus, with many infected people not having any symptoms. There is a possibility of the development of chronic infection. The virus is spread by blood

to blood contact and there are no special precautions required by staff, other than observing standard principles of infection control. (ASA, 2004).

Due to the nature of the profession and the invasive therapies included in their scope of practice, ambulance staff members are at serious risk of being exposed to these viruses, however, they normally reside in a living host and cannot multiply outside of a living cell (USFA, 2002). Therefore, it is seldom possible to culture viruses from samples taken from inanimate surfaces in the environment (Coovadia, 2007).

2.8.1. Ambulance surveillance studies

This author could not locate any guidelines, either nationally or internationally regarding microbiological surveillance of ambulances as a means of controlling and preventing infection. Three surveillance studies on microbial contamination of ambulances have been identified. Nigam and Cutter (2003) conducted a preliminary investigation to determine levels of bacterial contamination of Welsh emergency ambulances in three geographic regions. Specific sites within emergency vehicles were swabbed, before and after cleaning, to assess how effective current cleaning protocols were in reducing bacterial contamination.

This was a twelve month study. Sampling was conducted on a monthly basis. The on-call paramedic was asked to swab the seven allocated areas of each vehicle, once before cleaning, and once immediately after general vehicle cleaning and drying. Each month, 14 swabs (seven before cleaning and seven after) were sent to the laboratory for culture. The swabs were preserved in charcoal and sent to laboratories where they were directly plated onto blood agar culture media and incubated at 37 degrees Celsius for 48 hours.

Results obtained after the culturing of swabs indicated that most areas within emergency vehicles were contaminated with bacteria. Almost 61% of sites swabbed had bacteria present before cleaning. This figure was reduced to about

35% after cleaning. The species of bacteria most commonly found before cleaning were the *coliforms* (31,5%), *Staphylococcus epidermidis* (30.1%) and *Bacillus* species (21.9%). The species of bacteria most commonly found after cleaning were the *coliforms* (26.5%) and *Staphylococcus epidermidis* (29.4%).
Most swab sites showed a reduction in bacterial count after cleaning. However, there were still many contaminated sites and there was fresh contamination in some areas. For example, 33.4% of steering wheels were contaminated before cleaning, but 41% were contaminated afterwards. This led the researchers to believe that the cleaning equipment itself was a source of infection.

In the discussion, the authors noted that at the time of the investigation, there seemed to be no prescribed cleaning schedule. Cleaning materials and equipment varied, and the fact that cleaning occasionally increased the bacterial load and introduced new species on to equipment suggests that adequate decontamination of the cleaning equipment itself does not take place.

At the time of the study, ambulance crews reported that it was often only possible to clean a vehicle once during a shift. The availability of cleaning equipment and detergent was often minimal and inadequate. The amount of time available for cleaning the ambulance before the next call was a critical factor in the level of attention a vehicle could receive. There was no designated cleaning equipment or standardized cleaning protocol. The possible reasons given for the findings of the study is consistent with this author's own EMS experience.

The authors concluded that the ambulances examined, exhibited an unacceptably high level of contamination although most of the species of bacteria found were harmless, non-pathogenic species found naturally on skin and on environmental surfaces. Some, however, such as *Staphylococus aureus* are potential pathogens.

The second surveillance study, by Galtelli, Deschamp and Rogers (2006) was an assessment of the prevalence of pathogenic micro-organisms in one hospital-based rotor wing air ambulance programme. The authors commented that although much research has assessed the hospital's role in the transmission of micro-organisms, little in the literature relates to the out-of-hospital transport industry's role in the transmission of HCAIs.

The study had two main objectives: To assess the potential for HCAI transmission by a helicopter air-ambulance and to evaluate the effectiveness of the flight team's cleaning process.

The study began with the aircraft undergoing a routine cleaning after a typical patient flight. Surface wipe samples were taken from each of the seven sites chosen using a sterile cotton-tipped swab. After obtaining the initial samples, surfaces were cleaned again and a second set of surface wipe samples were obtained. The same process was repeated a week later. All samples were streaked onto blood agar and incubated for 48 hours under standard laboratory conditions. After 48 hours of incubation, cultures were examined and micro-organisms were identified using standard microbiology laboratory procedures.

Of the 14 swabs obtained after initial cleaning, 86% had bacterial growth. *Staphylococcus* grew on samples from all sites except the radio knobs. Areas of heaviest growth were in the patient compartment. These included *Pseudomonas, Staphylococcus, Aspergillus* and *Bacillus* sp.. This study did not specify whether or not the *Staphylococcus* identified was *Staphylococcus aureus.* The authors claimed that of all the organisms that grew on culture, none are considered virulent pathogens. These organisms would generally not pose as a threat to a healthy individual. However, several are opportunistic pathogens that may pose a threat to patients compromised by disease or trauma.

It was concluded that there was a potential for the helicopter air-ambulance to be a medium for disease transmission. The study also demonstrated that standard cleaning procedures were not adequate to eliminate bacterial growth on surfaces typically found in the patient compartment.

The third surveillance study by Roline, Crumpecker and Dunn (2007) was an initial screening study of methicillin resistant *Staphylococcus aureus* (MRSA) contamination in an ambulance fleet. This was a cross-sectional study of MRSA contamination in an ambulance fleet operating in the western United States.

The 21 ambulances, representing approximately two thirds of the total fleet, were selected on the basis of their availability. Five specific areas within each of 21 ambulances were swabbed with Dacron swabs moistened with sterile saline solution. These samples were immediately plated onto mannitol salt agar. The plates were incubated at 37 degrees Celsius and colony growth and agar colour change were assessed at 48 and 96 hours. Of the 21 ambulances sampled, 47.6% tested positive for MRSA.

The results of this preliminary cross-sectional screening study suggest that ambulances operating in the EMS system may have a significant degree of MRSA contamination and may represent an important reservoir in the transmission of potentially serious infections to patients. The authors also concluded that additional research examining the degree of MRSA contamination in the EMS setting as well as studies to evaluate effective methods of preventing its spread via the ambulance environment would help in preparing for this next challenge.

The sites chosen for sampling in the above three studies were:

- stretcher mattress (Nigam and Cutter, 2003; Deschamp and Rogers, 2006; and Roline, Crumpecker and Dunn, 2007);
- inside cupboards or drawer corners (Nigam and Cutter, 2003);
- inside Entonox mask (Nigam and Cutter, 2003);
- inside suction bottle (Nigam and Cutter, 2003);
- stretcher tracks or floor (Nigam and Cutter, 2003);
- inside and exterior door handles (Deschamp and Rogers, 2006);
- buttons on cardiac monitor and ventilator (Deschamp and Rogers, 2006);
- seat tracks (Deschamp and Rogers, 2006);
- helicopter gear levers (Deschamp and Rogers, 2006);
- radio control knobs (Deschamp and Rogers, 2006);
- patient head set (Deschamp and Rogers, 2006);
- steering Wheel (Nigam and Cutter, 2003; Roline, Crumpecker and Dunn, 2007);
- stretcher handrail (Roline, Crumpecker and Dunn, 2007);
- work area to the right of patient (Roline, Crumpecker and Dunn, 2007) and;
- Yankauer suction tip (Roline, Crumpecker and Dunn, 2007)

Whilst these three studies provide important information about ambulance contamination, there are some criticisms of the methods employed. Firstly, none of the studies make any mention of measures being taken to ensure against cross-contamination of the samples during collection. It is also possible that cleaning processes were changed as a result of the reactivity effect of being observed.

Secondly, in Nigam and Cutter's study (2003), different paramedics collected the samples over a 12 month period. Neither Galtelli et al. (2006) or Roline et al. indicate who collected the samples. Since none of these studies mention any training for correct and standardized specimen collection, the reliability of the results could be questioned.

A further criticism concerns transport times, from the time of collection to the time of culture at laboratories, which are not provided by these studies. The results of these studies may therefore have been compromised. Within a few hours, the sample could have changed as there could have been positive or negative growth of microbes during transport (Seuke, 2005).
A criticism of the Nigam and Cutter (2003) study by Simmons (2003) was that no attempt was made to quantify levels of bacteria. He goes on to state that quantitative methods take a measured area of a given surface and bacterial enumeration allows for the assessment of reduction of bacterial load after a cleaning process. No attempt was made to quantify the amount of MRSA in the Roline, Crumpecker and Dunn (2007) study either.

In microbiology, colony-forming units (CFU) is a measure of viable micro-organism numbers, unlike in direct microscopic counts where all cells, dead and living, are counted (Wikipedia, 2007). For convenience, the results are given in a semi-quantitative measure as:
Scanty indicates few colonies
Moderate indicates light growth
Profuse indicates heavy growth
(Galtelli et al.2006)

Another potential oversight of the Galtelli et al. (2006) study was that no microbiological sampling was done before the initial cleaning process. A comparison of microbial load before and after the survey could have lead to an indication of the degree of effectiveness of the cleaning protocol. It would also have been interesting to note what species of organisms were present before the initial cleaning.

The researcher has gained important knowledge from the criticisms of the studies mentioned above, and because of this, has identified the relevant conceptual framework for his own study problem. They have provided

information that has influenced the design and data collection methods of his study. Although the above studies had limitations, they are none the less landmark studies, in that they make a valuable contribution to our limited understanding of EMS IC and prevention.

2.8.2. Preventing / controlling transmission of infectious agents

The second component of AICPs involves measures to prevent and control the transmission of infectious agents. The chain of transmission is broken when there is an interruption at one or more of the links. The goal of an infection prevention and control programme is to break the chain of transmission thus preventing the spread of the agents which may cause diseases (Emergency Health Services Branch (EHSB), 2007). This may be accomplished by the maintenance of high standards of cleanliness on all surfaces and equipment. All staff have an individual responsibility to keep the ambulance clean and thus to reduce the risk of cross infection to themselves, their colleagues and their patients. Unless otherwise stated, all sources of information have been gathered from the USFA (2002) and ASA (2004) guidelines.

2.8.2.1. Ambulance decontamination

Decontamination is the physical or chemical process of reducing and preventing the spread of hazardous biological materials by persons or equipment (National Fire Protection Agency (NFPA), 2005). A decontamination programme has three levels comprising of cleaning, disinfection and sterilization.

<u>Cleaning</u>

Cleaning is a process which physically removes contamination but does not necessarily destroy organisms. Cleaning with hot water and detergent will remove soil, organic material, micro-organisms and bacterial spores from surfaces. After cleaning, surfaces should be thoroughly dried. Cleaning is an essential pre-requisite of equipment decontamination, to ensure that effective disinfection or sterilization can subsequently be carried out. As mentioned by

Pearse (1997), many disinfectants are inactivated by organic matter, hard water and other disinfectants. Disinfectants may not be able to get to bacteria because dirt may form a protective coat. A detergent is therefore needed to clean the area before the application of a disinfectant.

Disinfection and antisepsis

Disinfection is a process that reduces the number of viable micro-organisms on inanimate objects. Antiseptics are agents that kill or inhibit the growth of micro-organisms on the external surfaces of the body. Harmful micro-organisms can be destroyed by chemicals such as a chlorine releasing agent, or by immersion in hot water example, 70-80 degrees C. Disinfection processes can inactivate blood borne viruses but do not destroy bacterial spores such as tetanus.

Sterilization

This is a process that renders an object free from viable microbes, including spores and viruses. All clinical instruments and equipment used to surgically penetrate, or that could come into contact with breaks in skin, or mucosa must be sterile.

The decision to clean, disinfect or sterilize depends on the degree of risk from the source of infection.

Many types of disinfectants are available, however a small range, well chosen, and well controlled will prevent wastage, incorrect use and confusion (Pearse, 1997). All disinfectants used should be tuberculocidal as they should then be strong enough to kill all other bacteria and viruses of concern.

A chlorine bleach solution with concentrations ranging from 500ppm (1:100) to 5000ppm (1:10) depending on the amount of organic material present on the surface can be used to disinfect compartments, hard surfaces, or other areas of a vehicle or apparatus.

Reasonably inexpensive, combination disinfectant-detergents are also available. The advantage is that both cleaning and disinfection can be done in one operation (Pearse, 1997).

2.8.2.2. Alternate means of decontamination

Three other means of decontamination, apart from those indicated in the preceding section have been documented.

Ultraviolet C-band (UV-C) lighting can be added to ambulance disinfection procedures (Berlin, 2007). UV-C lights work by disrupting the DNA or RNA of micro-organisms rendering the cell incapable of reproducing. The UV-C unit is mounted in the ceiling of the patient compartment of the ambulance. The driver compartment is shielded. The patient compartment is "treated" once per shift and after any call with potentially infected patients. Exposure time is between five and ten minutes.

UV-C lights have many advantages:

- they are environmentally friendly without dangerous materials to handle or store – ambulance staff do not need to handle toxic chemicals;
- the lights are immediately effective, economical and operator friendly;
- ease of maintenance – they merely require periodic cleaning and an annual lamp change;
- ease of installation and;
- greater effectiveness against viruses than chlorine.

The disadvantages are that only illuminated air and surfaces will be disinfected and prolonged exposure is harmful to humans.

The manufacturer of a product, STERIS VHP® (Medical News Today, 2005), claims that VHP (Vapourized Hydrogen Peroxide) decontamination technology uses a low temperature, dry gaseous process that has proven to be highly

effective against micro-organisms. The process is easy to perform and the fast cycle time helps emergency service providers ensure the continuity of operations. The manufacturers claim that this system is far more effective than current ambulance disinfection practices. In a study by Dryden, Parnaby, Dailly, Lewis, Davis-Blues, Otter and Kearns (2007), hydrogen peroxide vapour (HPV) was used for decontamination in the control of a polyclonal MRSA outbreak on a surgical ward. The study found that HPV virtually eradicated environmental MRSA in the ward.

Copper is known to have activity against bacteria and fungi. Mehtar, Wiid and Todorov (2008) conducted a study in South Africa to establish the in-vitro activity of copper and its alloys against highly multiple-antibiotic-resistant nosocomial pathogens, yeast and *Mycobacterium tuberculosis*. The results showed that copper and its alloys demonstrated a marked inhibitory effect on the micro-organisms tested. The authors concluded that the incorporation of copper in healthcare facilities could reduce the environmental bio-burden and could be a useful adjunct in the fight against infection. They also recommended that the application of copper touch-surfaces example doorknobs, in healthcare facilities should be evaluated.

These alternate means of decontamination seem to have merit, but should be seen as adjuncts to ambulance decontamination and not as a replacement. One of the greatest stumbling blocks to efficient ambulance decontamination is time. The nature of EMS work allows little time for cleaning. These supplemental methods seem to require very little time for effective decontamination and deserve further evaluation. None of these means of decontamination has been mentioned in any AICP guideline.

2.8.2.3. Universal ambulance decontamination procedures

Decontamination procedures have been based on guidelines designed by the ASA (2004) in the United Kingdom and by the USFA (2002) in the United States. These guidelines have been designed to enable ambulance services to develop their own local procedures. Both sets are very similar. Therefore, to avoid repetition, the source of the information in the descriptions of the procedures hereafter should be regarded as coming from both these documents. However, information from only one set or other sources will be indicated by the insertion of a reference.

As stated earlier, the researcher has been unable to locate any formally documented decontamination procedures for the ambulance service under study. The Regulations for HBAs (South Africa, 2001) do however stipulate that the employer should ensure that adequate procedures are in place for routine care, cleaning and disinfection of environmental surfaces, and other frequently used or potentially contaminated surfaces.

Vehicle decontamination after each patient journey

No emergency or urgent call should ever be delayed as a result of a vehicle being washed or cleaned. Routine vehicle cleaning should take place after transport of every patient if possible. Detergent wipes can be used in order to clean all surfaces that may have been contaminated. This should take a few minutes. Linen, if used, should be changed in between patients. Cleaning of blood and body fluids must take place following the handover of the patient to the receiving facility and prior to the next call.

Vehicle decontamination at the end of shift

Both departments recommend the daily cleaning of ambulances. Using a designated mop, the floor should be cleaned with a fresh hot water and soap solution. If the mop becomes contaminated with body fluids, it should be changed immediately. Other ambulance surfaces and equipment should be washed as

above, using a disposable cloth and dried with disposable paper towels. If operational demands sometimes restrict regular end-of-shift cleaning, it must be done as soon thereafter as is convenient.

Weekly vehicle decontamination

All ambulance interiors should be subjected to a comprehensive clean on a weekly basis. It is accepted that operational demands are likely to restrict opportunities for the weekly clean to be undertaken at a designated time and date. The arrangements should form part of the vehicle cleaning roster designed and agreed with staff to ensure that each vehicle is cleaned on a regular basis.

All equipment and detachable items should be removed in order that all surfaces can be accessed for cleaning. It must be ensured that appropriate items of personal protection equipment (PPE) are worn and the vehicle is well ventilated. All walls, ceilings, surfaces of the driver compartment, and the inside of cupboards can then be cleaned. Usually a general detergent using disposable towels or cloths will suffice, however areas of visible contamination with body fluids should be cleaned with an appropriate disinfectant.

Clinical waste disposal

According to the Regulations for HBAs (South Africa, 2001), an employer shall, as far as reasonably practicable take steps to ensure that all HBAs are properly contained and controlled, to prevent the spread of contamination from the workplace. The international guidelines state that all single-use items should be properly disposed of after use (USFA, 2002). Grossly contaminated single-use items must be placed in a red bag or container marked with a biohazard seal. Disposal should follow the department's procedure. At the end of a shift, clinical waste bags should not be left in a vehicle. They should be removed, tied and put in the appropriate place for collection. No discarded clinical waste should remain in the interior of the vehicle at the end of shift.

Needles and other sharp objects should be placed in a puncture-proof container that is designated for biohazardous waste. Sharps box lids must be in the closed position. At the end of shift, the interior of the vehicle should be checked for sharps which should be removed.

Managing spillages of blood and body fluids

Disposable paper towels should be used to soak up excess fluid before applying bleach. The spill area should be covered with a chlorine releasing agent (5000ppm) for at least two minutes. Organic matter should be removed using the towels. The area should be cleaned with hot water and detergent; and thoroughly dried.

Decontamination of non-disposable equipment

Surfaces of non-disposable equipment that may have come into contact with a patient's body fluids must be cleaned with soap and water, disinfected with a bleach solution or sterilized in an autoclave, depending on it's application. Non-disposable equipment includes blood pressure cuffs, splints, spinal immobilization devices and laryngoscope blades, etc.

Non-disposable medical equipment like stethoscopes often have high rates of contamination (Maluf, Maldonado, Bercial and Pedrosa 2002). Regular cleaning of the diaphragm and its parts using an alcohol solution will remove accumulated organic substances.

The only study that could be located regarding EMS staff compliance with standard procedures for decontamination of non-disposable equipment was that by Goodman and Cone (2001), who attempted to determine whether EMS systems adhered to accepted equipment hygiene standards. Mail surveys were sent to EMS systems of 125 most populous US cities. The survey had a 68% return. The authors concluded that adherence to accepted hygiene standards among EMS systems in the United States were poor. Many systems did not use

soap and water prior to the use of alcohol or commercial disinfectant. Failure to do so may minimize the effectiveness of disinfection. Several systems used alcohol / disinfectant or soap and water alone, neither of which meets current standards for high-level disinfection. A possible criticism of the study was that the return rate was suboptimal, introducing the possibility of selection bias, particularly if those who did not respond were aware that they did not meet established standards. Another criticism of the study is that self-reporting was relied upon and may not be consistent with actual behavior. The last criticism is that no attempts were made to verify who actually completed the questionnaire (the survey was directed at the physician medical director of each EMS agency).

Ambulance cleaning equipment

Cleaning equipment such as brushes, cloths and mops should be colour coded to ensure that they are only used for ambulance decontamination and not general base cleaning to reduce the risk of cross-contamination (ASA, 2004).

2.8.2.4. Preventing / controlling transmission of infectious agents by other means.

Universal ambulance decontamination procedures for the prevention / controlling of transmission of infectious agents include vehicle decontamination after each patient journey, after every shift and per week. It also includes decontamination of non-disposable equipment, ambulance cleaning equipment, management of blood and body fluids spillages; and clinical waste disposal (USFA, 2002; ASA, 2004) There are also other means of breaking the chain of transmission of infectious agents.

Personal protective equipment

The Regulations for HBAs (South Africa, 2001) states that the employer shall, in the case of potential exposure to HBAs that can be absorbed through the skin, provide the employee with suitable impermeable personal protective equipment.

The USFA (2002) guide considers that all body substances should be considered as potentially dangerous since medical histories are often incomplete and differentiation between body fluids may be impossible. Protection is accomplished through the barrier technique, using personal protective equipment (PPE) such as gloves, masks, protective eyewear, gowns and resuscitation devices to prevent contact with potentially infectious materials, the selection of which is based on the anticipated risk of exposure to body fluid during the particular activity.

PPE should be cleaned, washed / laundered, or disposed of appropriately by the employer at no cost to the employee. All PPE, including uniforms, should remain at the worksite to prevent cross-contamination of family clothing.

Hand hygiene

Hand washing is the most effective overall IC measure (EHSB, 2007). According to the Regulations for HBAs (South Africa, 2001), hands should be washed after touching blood, body fluid, secretions, excretions and contaminated items, whether gloves are worn or not. When working with patients, hands should be washed immediately after gloves are removed, between patient contacts or where indicated, to prevent cross-contamination of different body sites.

Hands should be well lathered with regular soap and scrubbed for at least 15 seconds before rinsing and drying. When water is unavailable as in the case when ambulance staff are treating patients away from the ambulance, a waterless hand cleaner containing alcohol must be used (USFA, 2002). Rotter (2001) in his article, states that the use of non-aqueous ethanol or propanols offers some advantages over washing hands with either medicated or unmedicated soap in both hygienic and surgical hand disinfection. Alcohols exert the strongest and fastest activity against a wide spectrum of micro-organism except for bacterial spores and certain viruses, being little influenced by interfering substances. They are of low toxicity; the mode of application is simple

and much more economical of time than wash procedures – all features which help to increase the compliance with the rules of hand hygiene.

The guidelines established by the EHSB (2007) state that the use of an alcohol-based hand rub is the most effective type of hand hygiene. To be effective, alcohol-based hand rubs should contain 60 to 90% alcohol. When hands are visibly soiled, ambulance staff should ideally wash them with soap and water. If hand washing facilities are not available, visible soiling should be removed using a moistened towelette followed by the use of an alcohol-based hand rub. Moisturiser creams could be used following hand washing to prevent dry skin, which in turn will reduce the risk of skin breaks developing that could become infected.

Gloves

The Regulations for HBAs (South Africa, 2001) state that gloves should be worn when touching blood, body fluids, secretions, excretions and contaminated items. Clean intact gloves should be worn just before touching mucous membranes and non-intact skin. Gloves should be disposed of between tasks and procedures. Hands should be washed immediately after removal of gloves. A study conducted by Korniewicz, Laughon, Howard, Lytle and Larson (1990) showed that vinyl and latex gloves leaked bacteriophages in a simulated test by using stress manipulations designed to mimic patient care. The USFA (2002) guidelines specify that latex-free gloves must be provided for staff members with a latex allergy or for use when providing medical care to patients with a latex allergy. The need for this is endorsed by the National Institute for Occupational Safety and Health (1997).

Mask, eye protection and face shields

A mask and eye protection or a face shield must be worn to protect mucous membranes of the eyes, nose or mouth; or during procedures and activities that are likely to generate splashes or sprays of blood or body fluid, secretions and

excretions (South Africa, 2001). Ambulance staff members are particularly at risk as they are often involved in situations involving excessive exposure to blood, trauma, childbirth and other situations like being spat on, scratched or bitten by patients (ASA, 2004; Sanders, 2005).

Protection from airborne infectious agents

The Regulations for HBAs (South Africa, 2001), state that the employer shall in the case of airborne HBAs, provide the employee with suitable respiratory protective equipment and clothing. The employer shall ensure that information, instructions, training and supervision which would be necessary with regards to its uses are known to the employees. The directions of the USFA (2002) guide are more specific, recommending that when patients, who have confirmed or suspected tuberculosis are transported, a surgical mask should be placed on the patient and ambulance staff should wear respiratory protection masks of Class N95 or better (that is respirators that filter airborne particles 1 micron in size with a filtration efficiency of 95%). These masks must pass a “Fit Test” for maximum protection.

2.9. Infection control programme management / communication

Regular and frequent *ad hoc* inspections by managers of ambulances and their bases are essential in ensuring that the principles of IC policies are being followed (Surrey Ambulance Service, NHS Trust, 2004). An IC programme is incomplete without a formal evaluation process (USFA, 2002). Many types of data can be collected for such purposes, according to the USFA (2002). These include occupational disease exposures, work practices, adequacy of IC equipment and supplies, and employee interviews to determine individual knowledge and acceptance of IC protocols. Houang and Hurley (1997) argue that there is also a case to be made for common policies. Common policies could be designed for the entire EMS community in South Africa. Many elements could be standardized nationally, for example, colour coding, identification of “high risk”

patients, spillage and sharps policies, leaving other more parochial elements to be determined locally.

The Regulations for HBAs (South Africa, 2001) says that where workers are exposed to biological agents, information and instructions must be given to them or set out on notices displayed in the workplace. The regulations further state that a system must be developed to ensure that hospital patients, employees, contractors and visitors are educated about the use of precautions and their responsibility for adhering to the precautions. Management must make a periodic evaluation of adherence to precautions. The findings must be used to implement improvements.

The importance of good management in ambulance IC is indicated by Nigam and Cutter's (2003) findings, that the possible reasons for the contamination in the ambulances, were the lack of a prescribed cleaning schedule and incorrect or inappropriate cleaning methods. Decontamination of the cleaning equipment itself did not take place. There was inadequacy of cleaning and decontamination equipment, and insufficient time available for effective cleaning and decontamination.

2.10. Infection control education and training

Initial and refresher training and education are vital to ensure a successful programme (ASA, 2004; Houng and Hurley, 1996; Mehtar, 1995; USFA, 2002). Staff must be educated on safe working procedures and occupational risks to their health, particularly in respect of transmission of infection. Nigam and Cutter (2003) reported that a lack of IC education was a possible reason for the contamination of the ambulances in their study. The Regulations for HBAs (South Africa, 2001) state that an employer shall, before any employee is exposed or may be exposed, ensure that the employee is adequately and comprehensively informed and trained on both the practical aspects and theoretical knowledge with regard to HBAs as stipulated in the act.

Emergency medical care training in South Africa follows two streams, these being the short-course training undertaken at any one of 57 colleges nationally or the 3-year National Diploma in Emergency Care offered at four Universities of Technology situated in Durban, Cape Town, Johannesburg and Bloemfontein (Health Professions Council of South Africa, 2006). Some institutions have re-curriculated their courses and are now offering degree courses.

The vast majority of practitioners follow the short-course route of training that starts with a one month Basic Life Support (BLS) course. A further four month training programme will qualify the practitioner as Intermediate Life Support (ILS) trained. Advanced Life Support (ALS) training is offered through the nine month short-course route, by the various ambulance training colleges or the degree courses at the various tertiary education universities.

The researcher could not locate any evidence of education and training in IC in the various short courses offered by the State run training colleges in KwaZulu-Natal.
All the tertiary education institutions in South Africa do offer a module on IC and prevention as part of the curriculum.

2.11. Knowledge, practice and compliance

Changing behaviour and shifting social norms at multiple levels through the health care worker community are among the key challenges of IC today. To improve health care workers compliance with practices, IC professionals should learn from the behavioural sciences (Pittet, 2005). The promotion of safer and higher quality health care practices is a core function of IC programmes. This has traditionally been done by trying to influence safety behaviours through education and policy (Mah, Deshpande and Rothschild, 2006). These authors go on to state that interventions to change behaviour, have yielded disappointing results, with respect to such core practices as hand hygiene and the use of personal protective equipment. This author has located several studies that support this.

Houang and Hurley (1997) conducted a questionnaire survey on the knowledge and practices of hospital staff in IC. The survey showed that education of medical staff in the detail of written policies or procedures are required together with greater motivation to practice them. The authors state that knowledge of the risk alone, is not sufficient to motivate correct behaviour. Motivation to comply with IC recommendations appears to be a complex, habitual matter which proves difficult to influence. They cited a programme of creative IC which was based on psychological principles, using informality, creative activities and humour that was shown to be effective in improving some measurable IC outcomes. Possible criticisms of the study are the small sample size and possible collaboration between the respondents, in completing the questionnaire as researchers were not present during questionnaire administration.

A second study by Askarian, Shiraly and McLaws (2005) used a self-administered questionnaire to survey knowledge, attitudes and contact precaution practices among Iranian nurses. The authors concluded that the proportion of nurses who held positive attitudes also had good knowledge, but that compliance with practices was not abundant.

As with the previous study, a criticism was possible collaboration by the respondents as researchers were not present during questionnaire administration.

A third study by Stein, Makarawo and Ahmed (2003) conducted a questionnaire survey of doctors' and nurses' knowledge, attitudes and compliance with IC guidelines in Birmingham teaching hospitals. The sample size represented 7% of doctors and 4% of nurses. The respondents exhibited substantial lack of knowledge concerning transmission risks of Hepatitis B and HIV. The authors cited studies that showed also, that age is indirectly related to compliance with universal precautions, in that older health care workers seem to be less compliant. Furthermore, junior staff and students are likely to follow an incorrect

example set by their role models, thus perpetuating the cycle. The authors also cited two studies that show that nurses and junior doctors generally tend to be more compliant with universal precautions than senior doctors, possibly due to periodic performance appraisals that monitor their practices. The authors concluded that these reasons could explain non-compliance with universal precautions, like not washing hands or wearing of gloves.

The author's defended their use of a questionnaire survey as opposed to an observational study, as the effect of being monitored could have improved compliance as a result of the Hawthorne Effect. Possible criticisms of the study were:

- a lack of systematic sampling and small sample size;
- the self-selection of respondents and;
- possible collaboration by the respondents as researchers were not present during questionnaire administration.

A fourth study by Askarian, Honarvar, Tabatabaee and Assadian (2004) used a questionnaire survey to determine knowledge, practice and attitudes towards standard isolation precautions in Iranian medical students. The study revealed that there was poor compliance with standard isolation procedures among medical students. A possible limitation of the study, identified by the authors was that they were unable to observe the student participants. The results were solely based on their subjective views. They assumed that levels of practice are even lower than reported.

The results of all four studies have a common theme: knowledge alone is not sufficient to motivate correct behaviour. Non-adherence to IC behaviours such as performance of hand hygiene is typically multifaceted and extends beyond simple lack of awareness or forgetfulness.

Farr (2000) in his paper cited studies which showed that there were a number of variables that predicted compliance. Women comply more frequently than men, and nurses more often than physicians. When clinicians become very busy, they comply less frequently. He further goes on to state that in several instances, such as societal and economic pressures, the consequent institutional decisions have resulted in significant understaffing and epidemic infections. In this setting, the hospital's culture and tradition are not supportive of compliance.

Pittet (2005) in his article states that successful strategies to improve IC practices result from their multidimensional aspect. This is further demonstrated by Mah, Deshpande and Rothschild (2006) who talk about social marketing concepts to change health care workers' behaviours. This author will attempt to explain these concepts in the context of hand hygiene promotion among ambulance staff, as hand hygiene is the most effective overall IC measure (EHSB, 2007).

Social marketers devise marketing strategies based on the elements of Product, Price, Place and Promotion. Marketers seek to offer a beneficial product at a low price that is conveniently placed and compellingly promoted. For example, EMS management may install antiseptic handrub dispensers in accessible locations, like the driver and patient compartment, or offer portable bottles of handrub that could be carried in medical kit-bags or on a holster device. Potentially marketable benefits, include ease and convenience of handrub use, in a chaotic setting such as a multiple car pile-up or a mine shaft collapse. This amounts to a secure feeling of knowing that handrub effectively kills pathogenic micro-organisms on one's hands, or a sense of personal pride derived from working in an EMS system with low rates of HCAI.

Price is the tangible or intangible cost of performing a desired behaviour. A high price is dry skin or skin cracking if performing hand washing frequently. The greater tolerance of skin to antiseptic handrub allows ambulance staff to perform hand hygiene at a lower price (fewer skin problems). Not having access to soap and water at an accident scene is another high price of hand washing. The

immediate access to portable alcohol-based handrub lowers the price of hand hygiene.

Place refers to the location at which the social product is available to audiences. Demand for a product is influenced by it's convenience and accessibility. The provision of antiseptic handrub close to the point of care and in highly visible locations, makes hand hygiene more accessible and promotes usage.

Promotion is defined as the communication-persuasion strategy and tactics that will make the product familiar, acceptable, and even desirable to the target. To enhance the benefits of a desired behaviour, marketers may also offer financial or non-financial incentives such as awards or gift certificates.

There is a dictum in advertising that a message is not internalized until it is seen or heard at least five times. Hand hygiene can be promoted through numerous communication channels like newsletters, pay envelopes, computer screen savers, posters or interpersonal communication.

Most literature on IC knowledge, practice and compliance demonstrates that the IC community understands the importance of motivation, opportunity, and ability in health care worker behavioural adherence. Although the concept of hand hygiene was used to explain the concepts of social marketing, social marketing can be used to influence compliance and behaviour in a number of IC settings. Social marketing is a systematic and coherent paradigm for thinking about behaviour change issues and gives managers an understanding of what they should do to manage the environment of behaviour change and thus behaviour itself (Deshpande and Rothschild, 2006).

2.12. Infection control aspects of employee health

The USFA (2002) guide states that all EMS organizations must participate in a health maintenance process. This process, as it relates to infection control, includes:

- access to an appropriate immunization programme which includes immunization against influenza and Hepatitis B;
- members shall be offered immunizations for diseases as required by specific incidents or local conditions;
- access to tuberculosis screening on an annual basis;
- health maintenance programme which complies with National Fire Protection Agency's standards;
- the development of a confidential health database maintained for each staff member;
- in the event of an exposure, the member shall receive a confidential medical evaluation, post-exposure prophylaxis, counselling and evaluation and;
- a return to work policy.

The ASA (2004) guide states that the provider of Occupational Health Services must work closely with the services IC advisers, human resources and safety departments in:

- identifying and assessing the risks to staff of microbiological and chemical hazards;
- providing advice on appropriate control measures to avoid transmission of infection, including a suitable immunization policy and post exposure prophylaxis protocols;
- ensuring staff are informed and trained with regard to safe working procedures;
- monitoring and instituting health surveillance where appropriate;
- keeping accurate health and immunization records for each member of staff and;

- providing advice on the management of injuries at work, example Needlestick injuries.

In addition the guide states that recruitment procedures for all new staff must include an appropriate level of health check through Occupational Health Services. Staff should be educated on occupational risks to their health, particularly in respect of transmission of infection. Staff protection against the following should be checked: tuberculosis, poliomyelitis, rubella, tetanus, varicella and Hepatitis.

In the South African setting, hepatitis B and tuberculosis are of particular threat to ambulance staff. In support of this concern, Lee, Carrillo and Fleming (1997) stated that approximately 6500 to 9500 health care workers in the United States are annually infected with hepatitis B because of occupational exposure. In addition, the seroprevalence of hepatitis B infection among ambulance personnel ranges from less than 1% to 25%.

In a hospital wide study in Turkey by Hosoglu, Tanrikulu, Dagli and Akalin (2005) over a 15 year period, there were 22 health care workers with pulmonary tuberculosis out of an average of 734 workers per year over the study period. Paramedics represented 22, 7% of the infected workers. The authors went on to conclude that the education of nurses and paramedics for prevention of TB is important.

<u>Accidental exposure to blood / body fluids.</u>

The South Western Ambulance Service (2007) in it's IC guideline state that a sharps injury or contamination incident is defined as:

- inoculation of blood by a needle or other sharps;
- contamination of broken skin with blood;
- blood splashes to mucous membrane, example: eyes or mouth;
- contamination where clothes have been soaked by blood;

- body exudates or secretions through a wound or sore; and
- human bites or scratches.

The guidelines go on to give immediate advice after exposure:

- encourage bleeding from the wound by gently squeezing;
- wash the wound in soap and warm running water or with a disposable wipe if water is not available;
- irrigate eye or mouth splashes with plenty of water or saline;
- report the incident to management;
- if the source of the injury is known, document the details of person involved.

The South African Regulations for HBA (South Africa, 2001) require reporting guidelines for health care workers who have been exposed to HBAs. They state that any person shall immediately report to the employer, any possible accidental exposure to a HBA at the workplace, and the employer shall ensure that such incidents are investigated and recorded in accordance with the General Administrative Regulations.

2.13. Conclusion

Little attention has been given to the potential role that the out of hospital transport vehicle and ambulance staff might play in the spread of HCAI (Galtelli, Deschamp and Rogers, 2006) in general and in South Africa in particular. Given that poor ambulance IC practices poses a risk for both patients and staff, it is important to identify the types and levels of microbial contamination including that of potentially pathogenic species in ambulances and to determine knowledge and practices of staff in ambulance IC. Achieving this should help managers and researchers gain insight into the current status of IC and prevention in KwaZulu-Natal state ambulances. A comprehensive, EMS specific IC programme, based on international guidelines and standards, but appropriate to the South African setting could then be designed. This is essential, since well structured IC

programmes, according to Pearse (1997), have been shown to play a vital role in reducing mortality, morbidity and costs to both patients and the health care system.

CHAPTER THREE: METHODOLOGY

3.1. Introduction

In this chapter the methodology employed in this study with regards to study design, sampling, data collection, data analysis and interpretation, reliability of data and ethical issues will be presented.

3.2. Study design

The research design is the overall plan for obtaining answers to the research questions. The design incorporates key methodological decisions about the fundamental form of a study and spells out the strategies the researcher plans to adopt to develop information that is accurate and interpretable. The study was conducted in the postpositivistic paradigm, and was quantitative research. This approach calls for orderly, disciplined procedures with tight controls over the research situation to test the researcher's hunches about the nature of the phenomenon being studied and relationships among them (Polit and Beck, 2006). This was because objectivity was regarded as important for this study. The researcher endeavoured to be as neutral as possible whilst accepting that total objectivity was not possible. Empirical evidence from an ambulance service in the real world setting was systematically gathered by means of formal instruments that collected quantitative data. The concepts of interest were discrete and measurable.

This non experimental study used a descriptive design, as the purpose was to observe and describe aspects of ambulance IC (Polit and Beck, 2006). Descriptive designs are empirically driven abstractions that describe or classify specific dimensions or characteristics of individuals, groups, situations, or events by summarizing commonalities found in discrete observations. This study was cross-sectional as the data was collected during one data collection period. Cross-sectional designs are especially appropriate for describing the status of phenomena or relationships among phenomena at a fixed point. This is

appropriate as the researcher wished to capture the status of IC at that point in time and not to seek trends (Polit and Beck, 2006). A laboratory analysis was performed to determine types and levels of microbial contamination of ambulances, and a questionnaire was used to assess the ambulance IC knowledge and practices of staff. Part of this study was correlational as the researcher was trying to find a relationship between microbial contamination and knowledge and practice in IC. (Mouton, 2001; Polit and Beck, 2006).

3.3. Study setting

The study was conducted within a public sector EMS in Ilembe. The Ilembe district municipality is situated on the east coast of the Republic of South Africa. In contextualising the district, Ilembe is one of ten district municipalities in KwaZulu-Natal. The district comprises four local municipalities:

- Mandeni
- KwaDukuza
- Maphumulo
- Ndwedwe

There are four towns in the area – Ballito, KwaDukuza, Mandeni and Zinkwazi. Ndwedwe and Maphumulo are largely traditional agricultural areas.

The district covers 3260 square kilometres, and has a population of 577 073. It has a high population density, being 150.39 people per square kilometre. The HIV/AIDS status is 30% for the district as a whole. Figure 1 is a map of the KwaZulu-Natal health districts.

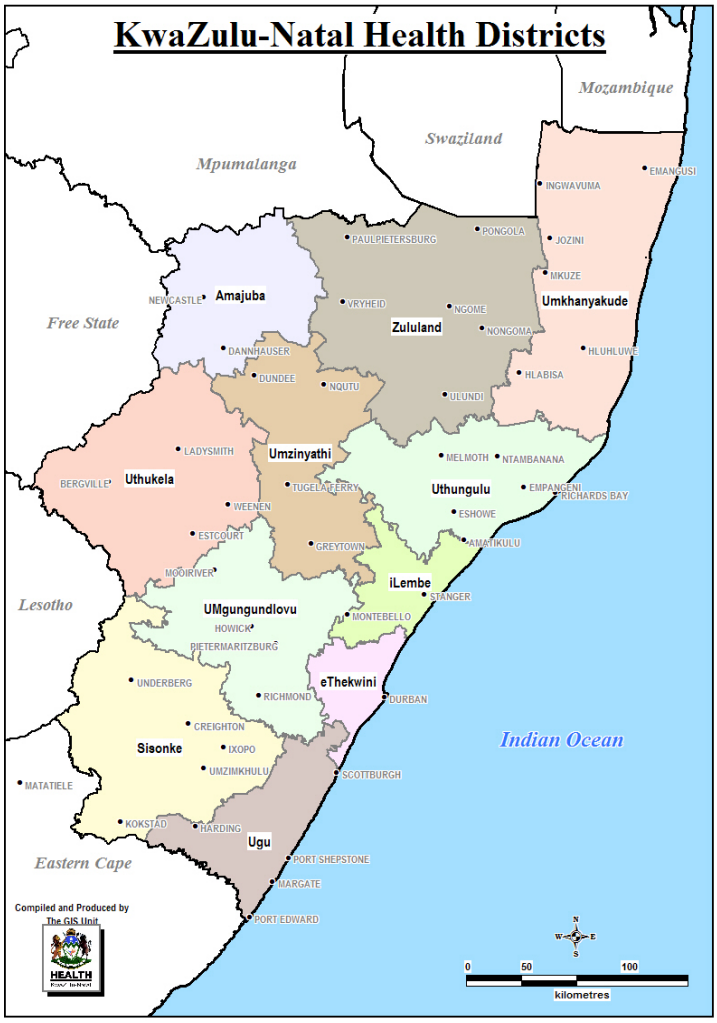

Figure 1. (Geographic Information Systems Unit, 2006)

The public health system of the district comprises of one regional hospital, three district hospitals, two community health centres, twenty nine fixed clinics and eight mobile clinics (Ilembe District Municipality, 2007). In addition, there is the 24-hour EMS under study, with 15 ambulances and 136 ambulance staff. Ambulances may be located anywhere in the chosen district at any given time. Ambulance staff members work a four shift system, rotating through a cycle of two days on, two nights on and four days off duty. Each shift is 12 hours long, and shift changeover occurs at 07h00 and 19h00.

3.4. Microbiological survey

Objective 1: To determine the types and levels of contamination of bacteria and fungi in ambulances including those that are potentially pathogenic.

3.4.1. Population

As noted above, there are 15 ambulances in the public sector EMS in the Ilembe District of KwaZulu-Natal. All of them were surveyed. They are distributed across the six ambulance bases. Response vehicles were not included in the study, as they are not used to transport patients.

Each ambulance was assigned an identification code (A/1, B/3 etc) depending on which ambulance base it came from. The actual registration number of the ambulances and their respective bases were known to the researchers only.

3.4.2. Sampling strategy

3.4.2.1. Sampling method

Although all the ambulances were included in the study, cost consideration necessitated the selection of a sample of all the possible sites in each ambulance which could be checked for the presence of bacteria and fungi. Bacteria and fungi, once removed from a host, are difficult to find and culture from inanimate objects. Therefore the sites that are most likely to be contaminated were selected. For this reason, non-probability, purposive sampling was used (Babbie and Mouton, 2001).

As well as sampling the selected sites, it was also necessary to select the time when they were taken. Time sampling was used whereby the microbial samples were collected at a specific period in the working day of an ambulance (Mouton, 2001; Polit and Beck, 2006). Shift change is at 07H00 and at 19H00. Collection of samples took place between 17H00 and 21H00 hours at the ambulance base as it was during this period that the ambulances were most likely to return to the bases. This means that all the samples were collected at a similar time each day.

Furthermore, staff members tend to clean the ambulances before they hand them over to the staff coming on duty for the next shift. If the researcher did the collection during shifts and found contamination, staff could level criticisms against the study by arguing that it was understandable that contamination was present since the ambulances are only cleaned during shift change. Therefore, theoretically the levels of contamination should be lowest immediately after shift change (see Chapter Three, 3.4.3.2.1).

3.4.2.2. Criteria for selection of sites

There were two criteria, based on the literature that guided the selection of these sites. Firstly, they are commonly touched by staff and patient's hands, since in clinical settings, hands can cause cross infection by transferring transient micro-organisms between patients. Secondly, sites which are difficult to clean were chosen. These sites often harbour micro-organisms that have the potential to cause infection (ASA, 2004).

The following key sites in the vehicle and it's equipment were sampled:

1. Seat belt (commonly touched by hand).
2. Stretcher rails (commonly touched by hand).
3. Oxygen flow-control taps (difficult to clean).
4. Inside surface of suction apparatus reservoir (difficult to clean).
5. Inside surface of oxygen humidifiers (difficult to clean).
6. Stethoscope diaphragm (commonly in contact with surface skin).
7. Sphygmomanometer cuff internal surface (commonly in contact with skin).
8. Rear door handle (difficult to clean).
9. Steering wheel (commonly touched by hand).
10. Head end of stretcher mattress (commonly in contact with skin and hair).

In addition to the above, settle plates were used to detect airborne bacteria and fungi. Two settle plates were placed on either end of each ambulance patient compartment and exposed for one hour before being covered.

3.4.2.3. Characteristics of the sample

There are 15 ambulances in the public sector EMS in the Ilembe District of KwaZulu-Natal. All of them were surveyed. Twelve sites each, for the entire population of fifteen ambulances in the district were sampled in order for true representation.

3.4.2.4. Sample size

All 15 ambulances were surveyed. They are distributed across the six ambulance bases as indicated in Table 1.

Table 1: Ambulance distribution according to ambulance bases

Ambulance base	No of Ambulances
Base A	5
Base B	3
Base C	2
Base D	1
Base E	2
Base F	2
TOTAL	15

Therefore, a total of 180 samples were collected (12 sites in each of the 15 ambulances).

3.4.3. Data collection

The researcher contacted the Health Research and Knowledge Management Unit at the KwaZulu-Natal Department of Health, explained the study and the relevant methodology, and requested permission to conduct the survey (see Annexure 6). The approved research proposal was provided for more detailed information. Once this was granted, permission was then sought from the District Manager of the Ilembe District (see Annexure 7). The prospective participants had access to an information letter in English or in isiZulu (Annexures 1 and 2).

3.4.3.1. Pilot testing

The purpose was to test the data collection checklist (Annexure 11) and the feasibility of the data collection plan (Polit, Beck and Hungler, 2001). The pilot test was conducted at EMRS, Grey's hospital base, Pietermaritzburg on the 28th of September 2007 at 18h00.The data was not used for the study. Obtaining consent to participate, swabbing procedure, timing and coding of samples were tested. The two research assistants were present as part of training. The tool was then refined and the data collection plan altered.

3.4.3.1.1. Challenges / experiences encountered during the pilot test

The shift supervisor was present on arrival. Although permission was sought from the district manager, the shift manager was not aware of the study. All ambulances were out on calls as it was Friday afternoon, which is a busy period of the shift. The night shift staff started arriving for work from 6:30pm. The study was explained.

The swabbing of the sites seemed to be viewed with awe and mistrust. Most staff kept a respectful distance, although they were interested in the actual procedure.

The researcher reached the following conclusions after the pilot study:

- It is vitally important that the shift supervisors be aware, supportive and present during data collection.
- The letter of information should be posted in advance at the bases explaining the study without actual dates of data collection.
- A letter of support from EMRS management would also be helpful.
- Data collection should take place between 17h00 and 20h00, during the week or Sundays when ambulance case loads are not so high.
- There were no problems with specimen collection. It was decided to stick with the specimen collection procedure as stated in the methodology.

3.4.3.2. The data collection tool

Research assistants were used to help the researcher with the data collection in this study. The research assistants were a junior lecturer and a senior student at the department of Emergency Medical Care and Rescue. In order to avoid threats to the validity and reliability of the study, the assistants were trained in techniques of collecting samples to ensure against cross-contamination.

Specimens were collected at the ambulance base by the researcher or research assistants. Ambulance bases were re-visited until specimens from all the ambulances in the population were obtained. The data collection commenced on the 28th October 2007 and ended on the 3rd of December 2007.

The specimens were collected in a standardized, consistent manner for each ambulance as outlined further on in the text. Each swab sample was labelled with the ambulance identification code, ambulance base code and the swab site number using a permanent marker.
A checklist kept by the researcher contained details outlined in Annexure 11.

3.4.3.2.1. Specimen collection

Transport media (supplied by Lancet Laboratories), which contained a swab and transport media in a sterile re-sealable plastic tube was used for specimen collection and transport. For each ambulance, one sterile swab dipped in sterile water was passed across and rotated over the entire surface of each of the sites chosen to collect as much material as possible (Nigam and Cutter, 2003; Samsunder, 2007). A standard 4cm² surface area was chosen for sites that had a relatively large surface area, for example the head-end of the stretcher mattress. The surface area was measured by means of a template cut out of a sheet of plastic. The template was disinfected with 70% isopropyl alcohol before every application.

Immediately after each swab was used, it was replaced into the tube and sealed. If a swab was accidentally contaminated (by coming into contact with a surface that is not the designated site), it was discarded and a new sterile one was used. Swab specimens were transported and delivered to the Lancet laboratories in Durban the following morning.

Tests for airborne micro-organisms were achieved using blood agar and Sabauraud's agar settle plates. The two plates each were placed at either end of the ambulance patient compartment of each of the fifteen ambulances. The settle plates were exposed for 1 hour before being covered. The plates and swabs were stored at room temperature and delivered to the Lancet laboratories in Durban the following morning.

Average daily temperature and humidity was also recorded. As the microbial samples were collected from each ambulance, the following details were requested from the ambulance staff and recorded on the checklist (Annexure 11):

1. When was the ambulance last cleaned?
2. How was it cleaned?
3. How many patients were transported during the preceding shift?
4. What health problems did these patients have?

This data was recorded to explain possible variations in contamination of ambulances.

In addition, the ambulance identification code, ambulance base code, collection site code, date and time were recorded on the checklist, to ensure that the results for the specimen analysis was correctly associated with the above details.

3.4.3.2.2. Challenges with specimen collection

The first challenge was the unforeseen extension in the collection period. The researcher expected to complete specimen collection within two weeks. The laboratory could only process a maximum of 36 specimens (three ambulances) per week, due to logistical reasons. This resulted in the collection period being extended to five weeks, and involved additional travel with the associated increase in travel costs. It also meant that the research assistants had to give up more of their private time. Fortunately, two research assistants were trained in specimen collection. Trips were shared between both of them. The extension of the collection period did not adversely influence the study, as data collection occurred at irregular intervals and visits were unannounced beforehand. There was no perceived change in behavioural practice of the ambulance staff.

The second challenge was the sheer logistics of time and distance for specimen collection. Some of the bases like Base C, Base D and Base F were remotely situated in rural areas. An average round trip amounted to a travel distance of 200Km with an average of five hours of time spent per trip, including specimen collection. Some remote bases had to be re-visited due to the fact that some ambulances were not present during base visits. A total average of 1400 Km was travelled. Specimen collection time averaged a total time of 35 hours. It must be noted that some of the questionnaires were also administered during this time to improve efficiency.

The dates for the base visits were as follows:
Base A – 5th, 11th and 12th November 2007
Base B – 22nd and 28th October 2007
Base C – 28th October 2007 and 16th November 2007
Base D – 18th November 2007
Base E – 20th November 2007
Base F – 3rd December 2007

3.4.3.2.2. Challenges with processing of swabs

There were certain concerns regarding the use of the laboratory, due to the uniqueness of the request. The laboratory could not process too many swabs all at once. Four different agar plates had to be made up for each swab (180 swabs in total) in order to culture the different micro-organisms expected. Each swab would have to be cultured for up to 48 hours and then enumerated and species identified. This would put the turn around time at 36-72 hours. This, together with the laboratory's usual workload, meant that for logistical reasons it could only process between 24 and 36 swabs per 48 hours. The microbiologist was also not available on weekends except for emergencies.

Due to the laboratory being situated in Durban and the fact that some bases were located in remote regions (200Km) roundtrip, the expected data collection period of two weeks had to be extended to five weeks.

3.4.4. Data analysis and interpretation

3.4.4.1. Laboratory analysis

The swabs were inoculated onto the following plates and cultured in the following order:

1. Chocolate agar
2. Staphylococcal/Streptococcal agar
3. MaConkey agar
4. Sabaurauds agar

Plates that contained blood were incubated in a CO2 incubator. Other plates were incubated in an O2 incubator. Plates were then read after 24 hours and if no growth was observed, they were incubated for a further 24 hours, and all organisms identified according to standard laboratory protocol.

An attempt was made to culture and identify the following micro-organisms according to standard medical microbiology laboratory procedures (Murray et al. 2003):

Staphylococci

Streptococci

Coliforms, including, *E. coli*, *Klebsiella* sp., *Proteus* sp., *Enterobacter* sp.

Bacillus sp.

Diphtheroid sp.

Pseudomonas sp.

Yeasts and other fungi

A semi-quantitative analysis by measuring colony forming units (CFU) was adopted to determine viable bacterial and fungal colonies (Galtelli et al. 2006).

Tests for the detection of Extended Spectrum Beta-Lactamases (ESBL) was performed on all the coliforms isolated, by using ESBL detection discs contained in three paired sets of cartridges (Mast ID™, 2007), with the following formulation:

Set 1
Ceftazidime 30 micrograms
Ceftazidime 30 micrograms plus Clavulanic acid 10 micrograms

Set 2
Cefotaxime 30 micrograms
Cefotaxime 30 micrograms plus Clavulanic acid 10 micrograms

Set 3
Cefpodoxime 30 micrograms
Cefpodoxime 30 micrograms plus Clavulanic acid 10 micrograms

Oxacillin was tested (Murray et al. 2003) on all Staphylococcus aureus isolates to determine whether the isolates were sensitive or resistant to oxacillin (MRSA).

Settle plates, for airborne micro-organisms were also incubated for 24, up to 48 hours, and resultant micro-organisms identified.

No attempt was made to identify viruses or *mycobacteria.*

The results and reporting was according to the laboratory's standard operating procedures and this was sent to the researcher for data analysis.

Descriptive and inferential statistics using the SPSS statistical package (Version 15) were applied for data analysis of types and levels of bacteria and fungi.

3.4.5. Limitations of the microbiological survey

A possible limitation was that the prevalence of viruses and tuberculosis in the ambulances were not determined. Although viruses can spread disease through contact with inanimate surfaces, they normally reside in a living host and cannot multiply outside of a living cell (USFA, 2002). Therefore, it is seldom possible to culture viruses from samples taken from inanimate surfaces in the environment (Coovadia, 2007). In order to culture and identify *Mycobacteria*, fresh specimens, example sputum, are needed. This was not possible as data collection took place during a set period in the working day of an ambulance. Cost considerations for identifying viruses and tuberculosis were also beyond the scope of the study budget.

Another possible limitation, was that settle plates used to sample airborne micro-organisms were exposed for one hour only, during shift change. Although micro-organisms were identified from all plates, the exposure time could have been longer. This was not possible as this is an operational EMS system. The study could not delay or hamper operations in order to collect data. For practical and logistical reasons, the swabs and settle plates were kept at room temperature overnight, and transported only the next morning to the laboratory.

A further limitation was that some ambulances were swabbed before cleaning and some were swabbed after cleaning, the reason being that an ambulance was swabbed as soon as it was available at the base. To mitigate against the

possible differences in micro-organism contamination between both sample times, the following questions were asked of the staff during swabbing of all the ambulances:

When was the ambulance last cleaned?
How was it cleaned?
How many patients were transported during the preceding shift?
What health problems did they have?

Another limitation was the limited budget. Although 12 sites from each ambulance were sampled, the study would have been more comprehensive if further sites, for example the ambulance cleaning equipment and sites at the ambulance base crew-room were included in the study.

3.4.6. Validity and reliability of the microbiological survey

3.4.6.1. Validity

Validity relates to the soundness of the findings of a study (Polit and Beck, 2006). Three aspects are relevant.

3.4.6.1.1. External validity

A sound sampling strategy was designed in order to enhance the generalizability of the study findings to other settings. A large number of sites in all the ambulances were sampled. Furthermore, the ambulance bases are representative of others in the province. Visits to ambulance bases for collection of samples were unannounced. In addition, sample sites were not known to ambulance staff. This was necessary to prevent changes in behavioural practice of the staff.

3.4.6.1.2. Internal validity

A number of measures were planned to increase the likelihood that the independent variables (sample sites and bases) as opposed to other variables were influencing the dependent variables (types and levels of bacteria and fungi) in the study. Firstly, the research assistants were briefed on the standard principles of sample collection and were trained during the pilot test. Procedures to prevent contamination of samples were followed, example, researchers wore face-masks and gloves when collecting samples and swabs that accidentally touched a surface that had not been selected for swabbing was discarded.

The sampling procedure was designed to avoid selection bias, i.e. all ambulances were included in the study. Twelve sites each, for the entire population of fifteen ambulances in the district were sampled in order for true representation. This gave an accurate measure of levels of micro-organism contamination.

The collection of samples took place over as short a time period as possible and at the same time period of the day, to reduce maturation threat i.e. threats occurring as a function of time (Polit and Beck, 2006).

3.4.6.1.3. Instrument validity

Instrument validity is the degree to which an instrument measures what it is supposed to measure (Mouton, 2001, Polit and Beck, 2006).

To this end, an internationally accredited pathology laboratory was used to identify types and levels of bacteria and fungi including species that were potentially pathogenic, if any. Semi quantitative microbiological enumeration in CFU's was used to determine levels of contamination.

3.4.6.2. Reliability

Collection of samples were standardized i.e. samples were collected in exactly the same manner, from the same location per site using exactly the same surface area.

Settle plates were located at the same sites in the chosen ambulances.

The culture, anti-biotic sensitivity testing and identification was performed by a laboratory using the international ISO 17025 guide. Further quality assurance was ensured by the laboratory being SANAS (South African National Accreditation System) accredited.

3.5. Knowledge and practices survey

Objective Two: To evaluate the adequacy of the knowledge and practice of staff in ambulance infection control.

3.5.1. Population

The population for the study was all operational staff members working on the ambulances at all six ambulance bases of the public sector run Emergency Medical Rescue Service (EMRS) in the Ilembe District of KwaZulu-Natal. Each questionnaire was assigned a code, consisting of a base code (A to F) and a staff code (1, 2, 4, 7 etc.) depending on the number of staff members per base. Only the researchers had knowledge of the bases and staff names.

An example of the researchers' coding method is as follows:

Base	Base Code	Staff	Staff Code	Questionnaire Code
Stanger	A	Mr Smith	20	A/20

3.5.2. Sampling strategy

3.5.2.1. Sampling method

Ambulance staff members work a four shift system, rotating through a cycle of two days on, two nights on and four days off duty. Each shift is 12 hours long, and changeover occurs at 07h00 and 19h00. The nature of the profession is such that ambulance staff may be located anywhere in the chosen district at any given time.

For this reason non-probability, purposive sampling was used (Babbie and Mouton, 2001). All 136 operational ambulance staff were approached to participate in the questionnaire survey. Administering the questionnaire took place between 17H00 and 21H00 hours at the ambulance base as it was during this period that the ambulances were most likely to return to the bases. Bases were re-visited to include those staff that were missed on the first visit.

3.5.2.2. Criteria for selection

Selection criteria for inclusion in the study included all operational staff members working on the ambulances at all six ambulance bases of the district. These included Basic, Intermediate and Advanced Life Support Staff.

3.5.2.3. Characteristics of the sample

All operational staff members working on the ambulances at all six ambulance bases were invited to participate in the questionnaire survey. The total possible sample size was 136. See Chapter Three, 3.5.2.1.

3.5.2.4. Sample size

All operational staff members working on the ambulances at all six ambulance bases were invited to participate in the questionnaire survey. The distribution of staff according to ambulance base and qualification is reflected in Table 2.

Table 2: Distribution of population of operational staff in the Ilembe District, according to ambulance base and qualification

Ambulance base code	BLS	ILS	ALS	Total
A	21	25	4	50
B	29	2	1	32
C	6	8	0	14
D	8	0	0	8
E	15	1	0	16
F	14	2	0	16
TOTAL	56	62	6	136

3.5.3. Data collection

The researcher requested permission to conduct the survey from the KwaZulu-Natal Department of Health (see Annexure 6). The approved research proposal was provided for more detailed information. Once this was granted, permission was then sought from the District Manager of the Ilembe District (see Annexure 7). The prospective participants had access to an information letter in English or in isiZulu (see Annexures 1 and 2). All willing participants were required to complete a consent form which was in English or isiZulu (Annexures 3 and 4)

3.5.3.1. Development of the data collection tool

The structured questionnaire was designed to collect data on the knowledge and practices of staff, as well as routine aspects of ambulance IC (see Annexure 8). The routine aspects were essential in understanding and adding value to the evaluation of knowledge and practices of staff in ambulance IC. Questions were derived from the literature review on sound ambulance IC principles. Literature was used to guide the design of the questionnaire (Statpac Survey Software, 1997; Creative Research Systems, 2006; Polit and Beck 2006). Principles such as having a simple, uncluttered format, the sequencing of the questionnaire

items, clear, non-leading and non-threatening wording of the items, and the length of the instrument were considered (Babbie and Mouton, 2001).

In this survey, 30 fixed choice and 4 open-ended questions were used, the latter designed to collect more detailed information on specific aspects. Three point scales (ranging from “no, never”, “sometimes” to “yes always”) and nominal scales (yes / no) were also used. Some fixed-choice questions were in a five-answer format, the answers varying according to the question. Some of the fixed choice questions had an option: “other”. If “other” was selected, respondents were given the opportunity to explain the reason for this choice in the follow-up question.

The focus was on key principles of ambulance IC. Items in the questionnaire were grouped into the following categories:

- demographic characteristics (3 questions);
- IC knowledge (6 questions);
- IC procedures and practices (14 questions);
- policies and educational needs (6 questions);
- employer responsibility (4 questions); and
- general comments.

To assess ambulance staff IC knowledge, a weighted marking system was developed. There were six questions designed to evaluate knowledge. Fourteen questions were selected to evaluate practice. A score sheet was developed. (see Annexure 10). Scores were analyzed as a whole, according to question, as well as per base.

The questionnaire was available in English and in isiZulu (See Annexure 8 & 9), so that participants could answer in the language of their preference.

3.5.3.2. Pre-testing and pilot testing

The questionnaire was pre-tested and pilot tested. An information letter to the pre-test group was provided (Annexure 5).

The pre-test group comprised of seven Recognition of Prior Learning (RPL) students from the Department of Emergency Medical Care and Rescue with at least one year of operational experience each. These students were chosen because of their representativeness of the population and the convenience of them all being accessible in one place at the same time. The English as well as the isiZulu version of the questionnaire was tested (Annexures 8 and 9). Once completed, the questionnaire was reviewed and revised, based on discussion on the criteria outlined below:

- Language and terms needed to be understandable, unambiguous, inoffensive and non-threatening.
- Questions needed to be relevant to the research objectives.
- Complex wording of questions was to be avoided.
- The length of time to complete it had to be acceptable.

The purpose of the pilot test, as stated earlier, was to test the feasibility of the data collection plan (Polit, Beck and Hungler, 2001). The pilot test was conducted at EMRS, Grey's hospital base, Pietermaritzburg on the 28th of September 2007 at 18h00.The data was not used for the study. Obtaining consent to participate, acceptability of questionnaire, timing, and coding of the questionnaire was tested. The research assistants were present as part of training.

3.5.3.2.1. Challenges / experiences encountered during the pilot test

As mentioned in the discussion on the pilot study for Objective one, all staff members were out on calls as it was Friday afternoon, which is a busy period of the shift. The night shift staff started arriving for work from 6:30pm. The staff members were unaware of the study, so the study was explained to them.

Initially, they seemed suspicious about the study, but after talking to the research assistant they felt reassured and agreed to assist.

The staff members were concerned about their identity being revealed. A possible reason for this is that staff were reluctant to read the letter of information. The researcher then explained how confidentiality would be maintained. Some refused to sign the consent form. One staff member refused to participate because “he had no instruction from management”. Only one staff member opted to fill out the questionnaire in isZulu.

Most of the staff members seemed to have difficulty comprehending some of the more “wordy” open-ended questions and seemed reluctant to answer them as it required more time and effort.
One staff member did not want to answer certain questions truthfully as he was concerned that management would identify him from his handwriting.

Knowledge gained from the pilot study required that the following refinements be made to the questionnaire and data collection:

- The word “decontaminate” appeared to be confusing to the staff, judging from the amount of queries regarding it’s meaning. The word “decontaminate” was then changed to the word “clean”. A definition for the word “clean” (in the IC context) was provided for at the beginning of the questionnaire.
- Although all the ambulance staff (except one) opted to complete the English version of the questionnaire, most of the staff seemed to have difficulties comprehending the open-ended questions. The staff were also reluctant to answer these questions because of the time it would take to complete them. The researcher was concerned that some of these questions would not be answered for the above reasons. Valuable data could be lost. It was decided to simplify some of the questions without losing their meaning. Some of the questions were re-structured to illicit fixed-choice answers. This was

- The researcher reached the following conclusions after the pilot study:
    - It is vitally important that the shift supervisors be aware, supportive and present during data collection.
    - The letter of information should be posted in advance at the bases explaining the study without actual dates of data collection.
    - A letter of support from EMRS management would also be helpful.
    - Data collection should take place between 17h00 and 20h00, during the week or Sundays when ambulance case loads are not so high.
    - It seemed that the reason the study was viewed with suspicion was fear of the unknown. The above conclusions and corrections proved correct as there was a 90% response rate to the questionnaire survey in the main study.

3.5.3.3. Administration of the tool

The questionnaire was administered during the period of shift change (17h00 and 21h00 hours) as it is the most likely time to access the maximum number of staff. Ambulance bases were re-visited to access staff that were on rest days or unavailable during the first data collection visit. The data was collected during the period 28th October 2007 to 3rd December 2007.

Staff, consenting to participate, were required to fill in the questionnaire at the ambulance base, in the presence of the researcher or research assistants.

The following represents response rates per base:

Base A – 98%

Base B – 81%

Base C – 75%

Base D – 75%

Base E – 91%

Base F – 93%

3.5.3.4. Challenges in collecting the questionnaire data

The first challenge was the unforeseen extension in the collection period, as explained in Chapter Three, 3.4.3.2.2. Travel budget restraints meant that the researcher had to coincide questionnaire administration with specimen collection. This meant that data collection was extended to five weeks. However, there was no perceived threat to the study as a result of the extension in the data collection period.

The second challenge related to the logistics of time and distance required for questionnaire administration. Some of the bases like base C, D and F were situated in remote rural areas.

Number of base visits:

Base A – 5

Base B – 6

Base C – 2

Base D – 1

Base E – 2

Base F – 3

Research assistants were used to help the researcher with the data collection in this study. The assistants were briefed on the objectives of the study. All terminology was clarified. The importance of being impartial together with emphasis on anonymity of participants and bases were made clear. It was made

known to the assistants that staff participation was strictly on a voluntary basis. Training the assistants in questionnaire administration hoped to ensure that there were not any threats to the validity and reliability of the study.

A timetable for carrying out the survey was agreed upon with the base managers. Both sets of data (microbial samples and questionnaires) were sometimes collected during the same visit to the base.

3.5.4. Data analysis and interpretation

Responses to open-ended questions and those responses to "other" were coded. Thereafter, all responses for each participant were scored to evaluate their knowledge and practices (see Annexure 10). The total score for knowledge ranged from 0 to 9 and the practice score, from 0 to 45. In order to gain further valuable information, the fourteen practice questions were divided into ambulance cleaning and personal protection practices. These two scores were analysed as separate scores as well as an overall practice score.

Descriptive statistical data analysis was conducted using the SPSS statistical package (Version 15). Frequencies, tables and graphs were generated for the different questionnaire categories. Hypothesis testing grouped by ambulance base, using chi-square, and ANOVA was applied.

3.5.5. Limitations of the knowledge and practices survey

A possible limitation was the use of a questionnaire survey to evaluate the adequacy of the knowledge and practices of staff. Other means of evaluation could have been through an interview or an observational study. All three methods have their advantages and disadvantages. After careful consideration, taking into account the nature of the study, it was decided that a questionnaire survey would be the most valid based on the following (Polit, Beck and Hungler, 2001):

- The respondents were asked to respond to the same question in the same order and were given the same set of options for their responses.
- There was a balance between close-ended and open-ended questions.
- The purpose of using close-ended questions was to ensure comparability of responses and to facilitate analysis while the open-ended questions allowed for richer and fuller information to be gathered.
- The questionnaire was rigorously pre-tested and pilot tested.

The researcher aimed to sample all ambulance staff in the region. Interviewing each staff member would have been too time consuming. Data collection needed to be undertaken at shift change, during the normal operations of an ambulance service, so using an interview as a data collection tool could have interfered with operations.

If interviews were used as the research tool, the interviewees could possibly have felt intimidated because of the researcher's position at the Durban University of Technology. Questionnaires also ensured confidentiality.

Lastly an observational study would not have been the best choice for logistical reasons, as the number of staff, the unique nature of an operational EMS system and the travelling distances between remote bases would have made data collection difficult. An observational study could also change the behavioural practice of the staff (Hawthorne Effect).

3.5.6. Validity and reliability of the knowledge and practices survey

3.5.6.1. Validity

3.5.6.1.1. External Validity

All ambulance staff were included in order to increase the generalizability of the findings. They are regarded as being representative of other ambulance bases and districts in the province. The research design was fixed and the sampling

strategy was rigorously critiqued. The questionnaire covered all aspects of the objective, and was pre-tested and pilot tested.

3.5.6.1.2. Internal validity

All elements of the population were requested to answer the questionnaire. Only staff members who were part of the defined population were invited to take part in the study. This was intended to prevent selection bias and ensured an accurate measure of the knowledge and practices of staff in IC.

The questionnaire was administered and completed in the presence of the researcher or research assistants, so that participants did not assist each other with their responses.

The research assistants were briefed on the study objectives and questionnaire content, so that any queries from respondents were handled in a consistent manner. They were also further trained in questionnaire administration during the pilot study.

Response rates i.e., the number of people that participated in the study relative to the number of people eligible, has been made available in the research report. The intention is to expose any non-response bias (Polit and Beck, 2006).

The data was collected over as short a period of time as possible to avoid maturation threat.

3.5.6.1.3. Instrument validity

In this part of the study, the concept under consideration was the evaluation of the knowledge and practices of staff in ambulance IC, the instrument being a questionnaire. The design of the questionnaire was based on the literature review and especially effective IC practices, to achieve content validity. The questionnaire was pre-tested and reviewed by experts in the field of IC. The

instrument was checked for test-retest reliability (Polit and Beck, 2006). It was further tested during the pilot study. Participants could answer the questions in their first language. The research assistants were available, if needed, to translate all responses from isiZulu into English for entry into the data base, to prevent language related inaccuracies from occurring.

3.6. Ethical Considerations of the research project

The study aimed to address the ethical principles of research outlined by Polit and Beck (2006) as explained hereafter.

3.6.1. Principle of beneficence

3.6.1.1. Freedom from harm

Whilst the questionnaire contained items to assess IC knowledge and practices, they were phrased in a sensitive manner to prevent embarrassment. Furthermore, the identity of individuals and the bases where they were employed was kept confidential. Although it was possible that the researchers and laboratory staff may have come into contact with potentially pathogenic micro-organisms during the collection and analysis of samples, standard medical microbiological safety procedures were adhered to in order to prevent this.

3.6.1.2. Freedom from exploitation

Respondents that participated in the study were not disadvantaged in any way. The researcher did not exceed the time limit agreed upon for the completion of the questionnaire.

3.6.1.3. Risk / benefit ratio

There was no anticipated risk to participants. The study could contribute to reducing patient morbidity and mortality through HCAI. The study could also prevent work acquired infection amongst the ambulance staff. Therefore, the benefits outweigh the risk.

3.6.2. Principle of respect for human dignity

3.6.2.1. Right to self-determination

Responding to the study was voluntary and participants were free to withdraw themselves or their comments from the study at any stage and there was freedom from coercion.

3.6.2.2. Right to full disclosure

Informed consent was sought after full disclosure of the study in terms of the nature of the study, the right to withdraw and the right to participate, in a letter of information to the prospective participants. The researchers were also present to answer any queries or concerns. Contact details of the researcher and research supervisors were made available.

3.6.3. Principle of justice

This principle concerns the participants' right to fair treatment and their right to privacy. The staff members were made aware that there would be no prejudice if they declined to participate or withdraw from the study after agreeing to participate. Participants had access to the research personnel at any point during the study to clarify information. Participants were made aware that their privacy would be maintained at all times. Participants, ambulances and bases were not identified.

3.7. Objective three: To establish whether there was a relationship between the knowledge and practices of staff in ambulance infection control and the types and levels of bacteria and fungi in the ambulances.

This was investigated by correlating the analyses of the data from the first two objectives. Descriptive statistical data analysis was conducted by using the SPSS statistical package.

Responses to open-ended questions and those responses to “other” were coded and scored (see Annexure 10). Scores were analyzed as a whole, according to question, as well as per base.

A scoring system was developed for the quantity of all micro-organism species to obtain an overall micro-organism score for that sample.

Pearson's correlation tests were performed to determine whether there were relationships between knowledge and practice of ambulance staff in IC versus types and levels of bacteria and fungi.

3.8. Conclusion

The quality of a study depends on the decisions a researcher makes in conceptualizing, designing, and executing the study and in interpreting and communicating the study results (Polit, Beck and Hungler, 2001).

The choice of methodology and design was successfully defended during pre-testing and pilot testing. The study aimed to perform a microbiological survey on all the ambulances in the district. All of the fifteen ambulances were sampled. Swabs were taken from the twelve identified sites in each ambulance. A total of 180 swabs were cultured and the micro-organisms identified. This represents 100% of the population. The questionnaire was well received. A total of 122 out of a possible 136 staff completed the questionnaire. There were no exclusions.

There was thus a 90% participation rate. The strict adherence to the methodology ensured that there was minimal threat to the reliability and validity of the study. The participants saw the study as extremely valuable, where IC as part of their every day function was often given less priority.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1. Introduction

This chapter represents the results and discussion of these results, which has emerged from the data analysis for the three objectives of this study. The data for the analysis was derived from a microbiological survey of ambulances to determine contamination levels, as well as a questionnaire survey to determine IC knowledge and practices of ambulance staff. The data was then used to determine relationships between levels of contamination and adequacy of staff knowledge and practices in IC.

4.2. The first objective was to determine the types and levels of contamination of bacteria and fungi in ambulances including those that are potentially pathogenic.

4.2.1. Introduction

The first objective was to determine the types and levels of microbial contamination in ambulances, including those that are potentially pathogenic. A semi-quantitative analysis by measuring colony forming units (CFU) was adopted to determine viable bacteria and fungi. The species of micro-organisms found are going to be described. The first description is the species distribution by base, including types and levels of contamination, for the entire district. The second description is the species distribution, including types and levels of contamination, for the sites chosen. The species distribution of the coliform isolates will be described.

As mentioned in Chapter Three, 3.4.3.2.1., the following questions were asked of the staff during sample collection, to explain possible variations in contamination of ambulances:

- When was the ambulance last cleaned?
- How was it cleaned?
- How many patients were transported during the preceding shift?
- What health problems did these patients have?

Seven of the staff reported that they cleaned the ambulance at the beginning of the shift using soap and water and eight staff members reported cleaning the ambulances less than an hour prior to sample collection, using soap and water. The average number of patients transported during the shift was six. No significant health problems, example gastro-enteritis, were reported by the staff, for any of the patients transported.

In order to find out if there was a correlation between contamination levels and the time period for when ambulances were last cleaned crosstabulations were performed. There were no differences noted.

Antibiotic susceptibility testing

Antibiotic susceptibility tests were conducted on selected isolates. Extended spectrum beta-lactamase (ESBL) tests were performed on all the coliform pathogens isolated. Oxacillin was tested on all *Staphylococcus aureus* isolates to determine whether the isolate was sensitive or resistant to oxacillin (MRSA). Since none of the bacteria selected were found to be ESBL positive or oxacillin resistant, there will be no further reporting on this aspect.

Detailed findings and discussion of the results follows.

4.2.2. Species of micro-organisms identified according to ambulance base

Laboratory analysis of the 180 samples taken during the microbiological survey revealed the presence of the following microbial species:

- *Escherichia coli*
- *Corynebacterium* species
- *Klebsiella* species
- *Pseudomonas* species
- *Pseudomonas aeruginosa*
- *Enterobacter* species
- *Enterobacter cloacae*
- *Acinobacter* species
- *Citrobacter* species
- *Coagulase negative Staphylococcus/Staphylococcus epidermidis*
- *Bacillus* species
- *Micrococcus* species
- *Aspergillus* species

Although this was a preliminary investigation, it is important to establish whether there was a regional variation in species distribution. This information is necessary, as it could shed light on current ambulance cleaning practices at the different bases, and also provides valuable information when designing a comprehensive IC programme (Chapter Two, 2.11).

Table 3: Proportion of samples from which micro-organisms were cultured by ambulance base

Base	Microbial growth	Yes	No	Total
Base A	Frequency	57	3	60
	Percentage	95	5	100
Base B	Frequency	36		36
	Percentage	100		100
Base C	Frequency	21	3	24
	Percentage	87.5	12.5	100
Base D	Frequency	11	1	12
	Percentage	92	8	100
Base E	Frequency	23	1	24
	Percentage	96	4	100
Base F	Frequency	23	1	24
	Percentage	96	4	100

When viewed as percentages (Table 3), it can be seen that there is not much variation in contamination levels for the different bases.

Table 4 – Shows the colony counts of micro-organisms that were identified, and species distribution of these organisms according to ambulance base.

Of particular concern are the high levels of coliforms in base A and B, especially in light of the fact that there were no cases of gastro-enteritis. These two main ambulance bases in Ilembe are geographically close to each other and share similar staff and patient demographics. All *E. coli* and 66.67% of all *Klebsiella* sp. in the entire district were found at these bases. These two species are part of the coliform group of bacteria and are transmitted via the faecal-oral route. Pseudomonads may also be found colonizing the human gut. These two bases also accounted for 60% of all *Pseudomonas* sp. found. These bacteria are potentially pathogenic, especially to immuno-compromised patients.. Presence or absence of these micro-organisms is a good indication of the level of adherence to basic hygiene principles by staff as well as the patients they transport.

Aspergillus sp. was only isolated at Base B. Immuno-compromised patients are particularly at risk from this species of fungi (refer to Chapter Two, 2.5.3).

Base	Total colony growth for all sites per base			Species of micro-organisms identified												
		Yes	No	*S. epidermidis*	*Bacillus Species*	*E.coli*	*Corynebac species*	*Klebsiella species*	*Micrococ. species*	*Pseudomonas species*	*P.aeruginosa*	*Aspergillus species*	*Enterobacter species*	*E. cloacae*	*Acinobacter species*	*Citrobacter species*
Base A	Frequency	57	3	10.00	31.00	5.00	5.00	3.00	7.00	24.00	1.00		1.00		11.00	2.00
	Percentage	95	5	32.25	32.29	71.43	17.24	25.00	18.42	36.92	50.00		16.67		91.67	40.00
Base B	Frequency	36		3.00	23.00	2.00	11.00	5.00	8.00	15.00		2.00				
	Percentage	100		9.67	23.96	28.57	37.93	41.67	21.05	23.08		100.00				
Base C	Frequency	21	3	4.00	12.00		4.00	2.00	4.00	9.00	1.00		1.00	1.00		
	Percentage	88	13	12.90	12.50		13.79	16.67	10.53	13.85	50.00		16.67	16.67		
Base D	Frequency	11	1	4.00	5.00		2.00		7.00	4.00			1.00			1.00
	Percentage	92	8	12.90	5.21		6.90		18.42	6.15			16.67			20.00
Base E	Frequency	23	1	3.00	13.00		2.00	1.00	8.00	10.00			3.00	1.00		1.00
	Percentage	96	4	9.67	13.54		6.90	8.33	21.05	15.38			50.00	16.67		20.00
Base F	Frequency	23	1	7.00	12.00		5.00	1.00	4.00	3.00				4.00	1.00	1.00
	Percentage	96	4	22.58	12.50		17.24	8.33	10.53	4.62				66.67	8.33	20.00
Frequency Total				31.00	96.00	7.00	29.00	12.00	38.00	65.00	2.00	2.00	6.00	6.00	12.00	5.00
Percentage Total				99.97	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.01	100.01	100.00	100.00

Table 4: Frequency of isolation of micro-organisms by species and ambulance base

To investigate the null hypothesis that the levels of potentially pathogenic bacteria and fungi in the ambulances would not differ at the different bases, the Kruskal Wallis test was performed for each micro-organism. This non-parametric test for K independent samples was performed because the variables for the bases were nominal and the variables for the levels of micro-organisms were ordinal.

Results: Only the following bacteria showed significant differences by base:
Micrococcus sp. (p=.009);
Enterobacter cloacae (p=.005) and
Acinobacter sp. (p=.001).

Micrococcus sp. is very rarely implicated as a pathogen in humans and therefore will not be discussed further.

Enterobacter cloacae is a specific member of the coliform group of bacteria. All bases in fact had positive cultures for coliforms in general.

Acinobacter sp. is an environmental organism that was found in Base A and F, which in this study, reflects the extremes with respect to the number of ambulances present at those two bases respectively. Following on this, we therefore will not be discussing the particular significance of these findings. It most likely represents a chance finding.

These results indicate that the null hypothesis is supported, the exception being the above three bacteria.

Although microbial contamination was widespread throughout the district, possible reasons for the slight difference in contamination rates for base A and B, as compared to the other four bases are as follows:

- These bases together, operate 8 out of the 15 ambulances in the district. Because of the greater number of ambulances, more swabs were collected. When the number of swabs from these 8 ambulances are viewed in relation to the total number of swabs (N=180), there probably is not much variation in contamination levels for the different bases.
- The ambulances from these two bases sometimes share and service the same area, which has the greatest population density in the district of Ilembe. This equates to the patient case load being higher for these 8 ambulances. Higher case loads could equate to higher levels of micro-organism contamination than other bases, presuming that IC practices are similar across the district.
- Higher case loads mean less time to clean the ambulances, either between patients or at the end of shift.

Although microbial contamination was widespread throughout bases C, D, E and F, possible reasons for the lower levels of microbial contamination for particular species as compared to bases A and B are as follows:

- These bases are geographically distant from each other, and operate in rural or semi-rural settings. These bases could be viewed as satellite ambulance stations with a maximum of two ambulances each. Base D has one. This means that a smaller number of samples (maximum of 24 each of 180) were obtained as compared to bases A and B. There is thus a lesser likelihood of obtaining positive cultures.
- The ambulances from these four bases service an area with low population densities. This equates to the ambulance case load being lower for these ambulances. Fewer patients could equate to lower levels of micro-organism contamination than base A and B.
- A decreased case load compared to base A and B could mean more time to clean the ambulances, either between patients or at the end of shift. This could explain the slight difference between contamination levels.

In order to test the null hypothesis as a whole, that the levels of bacteria and fungi in the ambulances would not differ at the different bases, a scoring system was developed for all species. The variations in micro-organism growth level were coded as: 0 = no growth; 1 = scanty; 2 = moderate; 3 = profuse). The level for each specimen of each type of micro-organism was then scored. The overall micro-organism score for each specimen was obtained by summing the score for each type of organism identified in the specimen.

For the purpose of this study, the levels of contamination with coliforms between the bases were compared, as this would indirectly reflect the levels of hygiene in the population group under study. As indicated previously, there were no reports of patients with gastro-enteritis transported during the study period. Therefore, a coliform score for each specimen was obtained by summing the scores for *E. coli*, *Klebsiella* sp., *Enterobacter* sp., *E. cloacae*, *Citrobacter* sp., *Pseudomonas* sp. and *P. aeruginosa*. Similarly, a non-coliform score was obtained.

Inferential tests were performed to see if there were statistically significant differences in the scores of the bases. Initially, Levene's tests were performed to see if variances were equal, in which case ANOVA could be used. ANOVA was run and no significant differences were found between the bases.

Welch and Brown-Forsythe tests were run for all three scores (overall micro-organism score, coliform and non-coliform score). There was nothing significant to report.

The null hypothesis as a whole was accepted.

Pearson’s *r* was performed as a correlation test, as *r* summarizes the magnitude and direction of a relationship between the variables. Significant correlations were found between all three scores:

The overall micro-organism, with coliform result was .379 (significance at the p = .01 level). This is a weakly positive relationship. i.e. the higher the overall micro-organism score the higher the coliform score.

The overall micro-organism with non-coliform result was .662 (significance at the p = .01 level). This is a weakly positive relationship i.e. the higher the overall micro-organism score the higher the non-coliform score.

The coliform with non-coliform result was -.443 (significance at the p = .01 level). This is a weak negative or inverse relationship i.e. the higher the coliform score the lower the non-coliform score.

4.2.3. Species of micro-organisms identified according to site

Table 5 represents the collective frequency distribution of micro-organisms per site for all 15 ambulances in the district under study. Twelve sites were chosen.

Of the twelve sites checked for each of the 15 ambulances in the district, contamination was observed in eight of the sites in every instance. These were the seatbelts, stretcher mattresses, stretcher rails, oxygen flow taps, suction units, BP cuffs, rear door handles and steering wheels.

The remaining four sites had varying microbial growth for the 15 ambulances in the district. Positive microbial growth was in 11 of the settle plates, 12 oxygen humidifiers and 11 stethoscopes. These results indicate that the majority of selected sample sites were contaminated with micro-organisms. This is to be expected, since many sites contained generally harmless, non-pathogenic species, which are representative of the natural environmental and skin flora, with the exception of coliforms. Most sites pose a minimal risk of infection, provided that minimal, simple precautions; like hand-washing is adhered to.

However, of concern is the presence of coliforms in a large percentage of sites sampled, since this group of organisms is normally confined to the gut. This could indicate poor hygienic practices by staff as well as the patients they transport. Several of the other species identified are opportunistic pathogens that may pose a threat to patients compromised by disease or trauma. If these micro-organisms come into contact with oral, nasal, or ocular membranes, inoculation is possible. These organisms are also capable of causing disease if introduced directly into an open wound, common with trauma or burn patients (Galtelli, Deschamp and Rogers, 2006). *Aspergillus* sp. was only found at one base. No other fungi, in particular, *Candida* sp. were cultured in this study

Continuous, fresh sources of contamination are possible with every patient transport. Ambulance staff themselves regularly enter and exit their ambulances, thus enabling a steady supply of micro-organisms to be carried on board. As mentioned in Chapter Two, ambulances, because of the very nature of their role in offering prehospital care and transport to patients, cannot be expected to be sterile environments. Nor is this considered to be necessary (Nigam and Cutter,2003).

However, the results bring to the fore two very important points:

1. A high percentage of settle plates and oxygen humidifiers showed contamination. These sites reflect a greater potential of sources of infection via the airborne route. Settle plates sampled airborne micro-organisms. Oxygen humidifiers moisten bottled oxygen, by passing the gas through sterile water before reaching the patient. A positive finding was that there was no *Aspergillus* sp. cultured from the settle plates

2. There were high levels of contamination on seatbelts, stretcher rails and ambulance rear door handles. These areas in an ambulance are frequently touched by hands. Contact with the contaminated environment, equipment, etc,

will contaminate hands. The role of contaminated hands in the transmission of infections has been well reported as cited by Nigam and Cutter (2003).

Table 5: Frequency of isolation of microbes by site, species and quantity of growth.

Site	Micro-organism	No growth		Scanty		Moderate		Profuse		Total	
		Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Seat belt	*S. epidermidis*	15	100							15	100
	Bacillus sp.	6	40	2	13.3	5	33.3	2	13.3	15	100
	E. coli	15	100							15	100
	Corynebacterium sp.	11	73.3	4	26.7					15	100
	Klebsiella sp.	14	93.3			1	6.7			15	100
	Micrococcus sp.	13	86.7	2	13.3					15	100
	Pseudomonas. sp.	8	53.3	4	26.7	3	20			15	100
	P. aeruginosa	14	93.3	1	6.7					15	100
	Aspergillus sp.	14	93.3			1	6.7			15	100
	Enterobacter sp	12	80	3	20					15	100
	E. cloacae	15	100							15	100
	Acinobacter sp	14	93.3					1	6.7	15	100
	Citrobacter sp	14	93.3	1	6.7					15	100
Head-end stretcher mattress	*S. epidermidis*	13	86.7	1	6.7	1	6.7			15	100
	Bacillus sp.	7	46.7	3	20	5	33.3			15	100
	E. coli	15	100							15	100
	Corynebacterium sp.	11	73.3	2	13.3	2	13.3			15	100
	Klebsiella sp.	14	93.3	1	6.7					15	100
	Micrococcus sp	11	73.3	3	20	1	6.7			15	100
	Pseudomonas sp.	9	60	2	13.3	4	26.7			15	100
	P. aeruginosa.	15	100							15	100
	Aspergillus sp.	15	100							15	100
	Enterobacter sp.	15	100							15	100
	E. *cloacae*	12	80			1	6.7	2	13.3	15	100
	Acinobacter sp.	12	80			2	13.3	1	6.7	15	100
	Citrobacter sp.	13	86.7			1	6.7	1	6.7	15	100
Settle plate: Front-end patient compartment	*S. epidermidis*	12	80	2	13.3	1	6.7			15	100
	Bacillus sp.	3	20	2	13.3	5	33.3	5	33.3	15	100
	E.coli	15	100							15	100
	Corynebacterium sp	14	93.3	1	6.7					15	100
	Klebsiella sp.	14	93.3	1	6.7					15	100
	Micrococcus sp.	10	66.7	5	33.3					15	100
	Pseudomonas sp.	15	100							15	100
	P. aeruginosa	15	100							15	100
	Aspergillus sp.	15	100							15	100
	Enterobacter sp.	15	100							15	100
	E. cloacae	15	100							15	100
	Acinobacter sp.	15	100							15	100
	Citrobacter sp.	15	100							15	100

Site	Micro-organism	No growth		Scanty		Moderate		Profuse		Total	
		Freq	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**
Settle plate: Rear-end patient compartment	*S. epidermidis*	11	73.3	4	26.7					15	100
	Bacillus sp.	2	13.3	2	13.3	7	46.7	4	26.7	15	100
	E. coli	15	100							15	100
	Corynebacterium sp.	13	86.7			2	13.3			15	100
	Klebsiella sp.	15	100							15	100
	Micrococcus sp.	9	60	6	40					15	100
	Pseudomonas sp.	13	86.7	1	6.7	1	6.7			15	100
	P. aeruginosa	15	100							15	100
	Aspergillus sp.	15	100							15	100
	Enterobacter sp.	14	93.3					1	6.7	15	100
	E. cloacae	15	100							15	100
	Acinobacter sp.	15	100							15	100
	Citrobacter sp.	15	100							15	100
Stretcher rails	*S. Epidermidis*	11	73.3	4	26.7					15	100
	Bacillus sp.	7	46.7	3	20	5	33.3			15	100
	E. coli	15	100							15	100
	Corynebacterium sp.	9	60	3	20	3	20			15	100
	Klebsiella sp.	12	80	2	13.3	1	6.7			15	100
	Micrococcus sp.	13	86.7	2	13.3					15	100
	Pseudomonas sp.	9	60	3	20	3	20			15	100
	P. aeruginosa	15	100							15	100
	Aspergillus sp.	14	93.3			1	6.7			15	100
	Enterobacter sp.	15	100							15	100
	E. cloacae	15	100							15	100
	Acinobacter sp.	13	86.7			2	13.3			15	100
	Citrobacter sp.	14	93.3			1	6.7			15	100
Oxygen taps	*S. epidermidis*	14	93.3	1	6.7					15	100
	Bacillus sp.	7	46.7	6	40	2	13.3			15	100
	E. coli	14	93.3			1	6.7			15	100
	Corynebacterium sp.	14	93.3	1	6.7					15	100
	Klebsiella sp.	15	100							15	100
	Micrococcus sp.	12	80	3	20					15	100
	Pseudomonas sp.	7	46.7	4	26.7	4	26.7			15	100
	P. aeruginosa	15	100							15	100
	Aspergillus sp.	15	100							15	100
	Enterobacter sp.	14	93.3	1	6.7					15	100
	E. cloacae	15	100							15	100
	Acinobacter sp.	13	86.7			2	13.3			15	100
	Citrobacter sp.	15	100							15	100

Site	Micro-organism	No growth		Scanty		Moderate		Profuse		Total	
		Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Suction unit	*S. epidermidis*	14	93.3	1	6.7					15	100
	Bacillus sp.	8	53.3	3	20	4	26.7			15	100
	E. coli	15	100							15	100
	Corynebacterium sp.	13	86.7	1	6.7	1	6.7			15	100
	Klebsiella sp.	14	93.3	1	6.7					15	100
	Micrococcus sp.	14	93.3	1	6.7					15	100
	Pseudomonas sp.	3	20	1	6.7	5	33.3	6	40	15	100
	P. aeruginosa	15	100							15	100
	Aspergillus sp.	15	100							15	100
	Enterobacter sp.	15	100							15	100
	E. cloacae	15	100							15	100
	Acinobacter sp.	14	93.3	1	6.7					15	100
	Citrobacter sp.	15	100							15	100
Oxygen humidifier	*S. epidermidis*	15	100							15	100
	Bacillus sp.	14	93.3	1	6.7					15	100
	E. coli	15	100							15	100
	Corynebacterium sp.	14	93.3	1	6.7					15	100
	Klebsiella sp.	13	86.7	1	6.7	1	6.7			15	100
	Micrococcus sp.	14	93.3			1	6.7			15	100
	Pseudomonas sp.	8	53.3	3	20	3	20	1	6.7	15	100
	P. aeruginosa	15	100							15	100
	Aspergillus sp.	15	100							15	100
	Enterobacter sp.	15	100							15	100
	E. cloacae	15	100							15	100
	Acinobacter sp.	13	86.7	1	6.7	1	6.7			15	100
	Citrobacter sp.	15	100							15	100
Stethoscope diaphragm	*S. epidermidis*	10	66.7	3	20	2	13.3			15	100
	Bacillus sp.	13	86.7	2	13.3					15	100
	E. coli	15	100							15	100
	Corynebacterium sp.	14	93.3	1	6.7					15	100
	Klebsiella sp.	15	100							15	100
	Micrococcus sp.	13	86.7	1	6.7	1	6.7			15	100
	Pseudomonas sp.	11	73.3	2	13.3	2	13.3			15	100
	P. aeruginosa	15	100							15	100
	Aspergillus sp.	15	100							15	100
	Enterobacter sp.	15	100							15	100
	E. cloacae	14	93.3	1	6.7					15	100
	Acinobacter sp.	15	100							15	100
	Citrobacter sp.	15	100							15	100

Site	Micro-organism	No growth		Scanty		Moderate		Profuse		Total	
		Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
BP cuff internal surface	*S. epidermidis*	11	73.3	3	20	1	6.7			15	100
	Bacillus sp.	6	40	4	26.7	5	33.3			15	100
	E. coli	12	80	2	13.3	1	6.7			15	100
	Corynebacterium sp.	14	93.3	1	6.7					15	100
	Klebsiella sp.	15	100							15	100
	Micrococcus sp.	11	73.3	4	26.7					15	100
	Pseudomonas sp.	11	73.3	4	26.7					15	100
	P. aeruginosa	15	100							15	100
	Aspergillus sp.	15	100							15	100
	Enterobacter sp.	15	100							15	100
	E. Cloacae	14	93.3			1	6.7			15	100
	Acinobacter sp.	14	93.3			1	6.7			15	100
	Citrobacter sp.	15	100							15	100
Rear door handle	*S. Epidermidis*	13	86.7	2	13.3					15	100
	Bacillus sp.	6	40	4	26.7	3	20	2	13.3	15	100
	E coli sp.	13	86.7	1	6.7	1	6.7			15	100
	Corynebacterium sp.	13	86.7	1	6.7	1	6.7			15	100
	Klebsiella sp.	13	86.7			1	6.7	1	6.7	15	100
	Micrococcus sp.	11	73.3	4	26.7					15	100
	Pseudomonas sp.	11	73.3	2	13.3	2	13.3			15	100
	P. aeruginosa.	14	93.3	1	6.7					15	100
	Aspergillus sp.	15	100							15	100
	Enterobacter sp.	14	93.3			1	6.7			15	100
	E. cloacae	14	93.3	1	6.7					15	100
	Acinobacter sp.	15	100							15	100
	Citrobacter sp.	15	100							15	100
Steering wheel	*S. epidermidis*	10	66.7	4	26.7	1	6.7			15	100
	Bacillus sp.	5	33.3	4	26.7	5	33.3	1	6.7	15	100
	E. coli	14	93.3	1	6.7					15	100
	Corynebacterium sp.	11	73.3	4	26.7					15	100
	Klebsiella sp.	14	93.3	1	6.7					15	100
	Micrococcus sp.	11	73.3	3	20	1	6.7			15	100
	Pseudomonas sp.	10	66.7	2	13.3	2	13.3	1	6.7	15	100
	P. aeruginosa	15	100							15	100
	Aspergillus sp.	15	100							15	100
	Enterobacter sp.	15	100							15	100
	E. cloacae	15	100							15	100
	Acinobacter sp.	15	100							15	100
	Citrobacter sp.	14	93.3			1	6.7			15	100

In order to test the null hypothesis that there is no difference between the sample sites within the ambulances and the levels of bacteria and fungi, inferential statistics were then used.

Kruskal Wallis (non parametric test for k independent samples) was applied to determine whether there was a significant difference between the site and the presence of each type of micro-organism.

Results: Only the following bacteria species were significantly different by site:

Bacillus sp. (p=.000)

Pseudomonas sp. (p=.000)

Table 6: Descriptive statistics: coliforms and non-coliforms by site

Site		Coliform score		Non-coliform score	
	N	Mean	Std. Deviation	Mean	Std. Deviation
Seat belt	15	1.1333	.91548	1.9333	1.48645
Stretcher handles	15	1.0000	1.00000	2.2667	1.22280
Oxygen taps	15	1.0000	.84515	1.2667	.79881
Suction unit	15	2.0000	1.06904	1.1333	.99043
Humidifier	15	1.0000	1.06904	.4667	.74322
Stethoscope diaphragm	15	.4667	.74322	.8667	.91548
BP cuff internal surface	15	.6667	.72375	1.7333	1.09978
Rear door handle	15	1.2000	1.37321	1.6667	1.29099
Steering wheel	15	.8667		2.1333	1.30201
Head end stretcher mattress	15	1.6000	1.18322	2.2667	1.57963
Settle plate: front end patient compartment	15	.0667	.25820	2.4667	1.30201
Settle plate: rear end patient compartment	15	.4000	1.29835	2.8000	1.37321
Total	180	.9500	1.08969	1.7500	1.34486

It can be seen from Table 6, that the mean coliform and non-coliform scores for the different sites appear to vary widely. The micro-organism scores were investigated for significant differences by site. Initially, The results for ANOVA for the coliform score by site was .000, whilst the results for the Welch and Brown-Forsythe tests for the non-coliform score by site, yielded a result of .000 (Levene's test result was .375, so ANOVA could not be used). It was therefore concluded that there were significant differences for these two groups by site.

Welch and Brown-Forsythe tests were applied for overall micro-organism score by site and yielded a result of .000 (Levene's test result was .375). It was concluded that there was a significant difference in the overall score and the sites.

Therefore, the null hypothesis that there would be no differences between the levels of bacteria and fungi and the sample sites was rejected.

4.2.4. Conclusion

The results presented in this study showed clearly that there is a wide variety of microbial contamination of ambulances in the district under study. Furthermore, there is a high level of potentially pathogenic species. Apart from three micro-organisms (*Micrococcus* sp., *Enterobacter cloacae* and *Acinobacter* sp.) there was little difference between the bases regarding the types and levels of contamination of ambulances. Similarly, there was no significant difference between the sample sites within the ambulances and the levels of bacteria and fungi, except for *Bacillus* sp. and *Pseudomonas* sp. The high levels of *Bacillus* sp. at most sites is expected, as these are generally harmless, non-pathogenic species, found in the natural environment. As described in Chapter Two, 2.5, of concern is the high levels of *Pseudomonas* sp., in all the sites, which can be an indication of poor hygiene practices as they may also be found colonizing the human gut, besides being environmental contaminants. There was no significant difference between the bases regarding the scores for microbial contamination.

4.3. The second objective was to evaluate the adequacy of the knowledge and practices of staff in ambulance infection control.

4.3.1. Introduction

A survey, using a self report in the form of a questionnaire, was conducted to evaluate the knowledge and practices of staff in ambulance infection control.

The questions on ambulance cleaning were not directed at how the staff would ideally want to clean the ambulances, but rather what was usually practiced. Data analysis was not aimed at the specific individual, but rather, at the different ambulance bases and the district as a whole. In some instances, questions were not answered. The unanswered questions were also reported upon in this discussion, as not answering certain questions, in itself is valuable information. Evaluation of the adequacy of the knowledge and practices of staff in ambulance infection control was based on and compared to internationally accepted standards on AICP, as described in Chapter Two, 2.7. Also, where relevant, references to the results of the microbiological survey will be made.

4.3.2. Demographics

Understanding the demographics of the area under study could reveal important associations and insights into IC practices and procedures of the ambulance staff. Collecting demographic information and converting them into variables is important in order to describe the sample. These variables will be examined in relation to relevant knowledge and practice variables later in the section, to see if they influenced or were related to them in any way. The results of the demographic analysis and subsequent discussion are presented below.

4.3.2.1. Age

In addition to being a good general descriptive variable, age is important, as studies have shown that age is indirectly related to compliance with IC practices and procedures (see Chapter Two, 2.11).

The average age of the staff in this study was 33.67 years. However, there was a wide range in ages, with the youngest being 23 years old and the oldest 57 years

of age. Of the 122 staff members who participated in the survey, seven did not divulge their age.

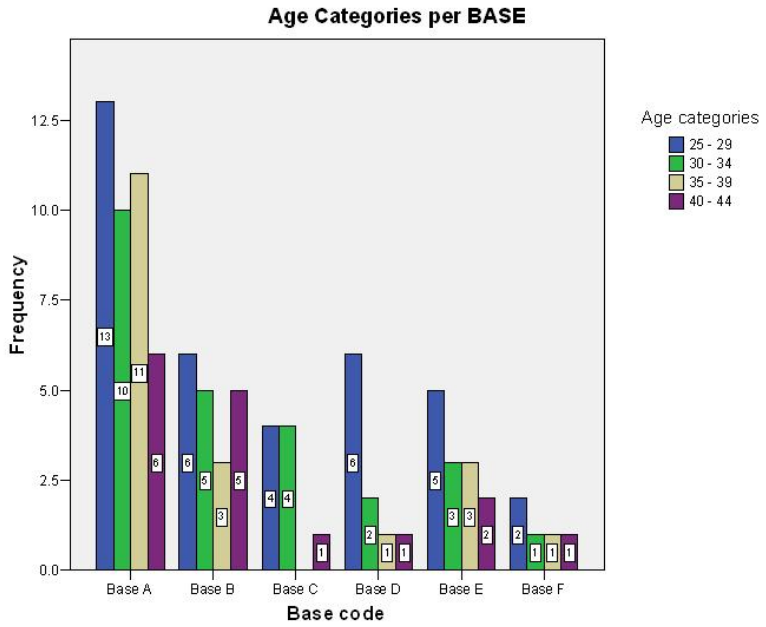

Figure 2: Distribution of respondents by age and base

The age distribution of respondents by base was examined (see Figure 2).

The mean age per base appeared to vary. In order to ascertain if they were significantly different and not that the differences reflected chance fluctuations, ANOVA was applied. ANOVA assumes equal variances within data sets. Therefore, before ANOVA was used, Levene's Test of Homogeneity of Variances was performed. It resulted in a significance level of .033, which was below the α of .05, indicating that there were approximately equal variances within the data sets being compared. ANOVA yielded an F ratio of 2.198. In a table of values for a theoretical F distribution, the value for F with df = 5 and 109 with an α of .05, is 2.29 (Glantz, 1997). This is greater than the F statistic of 2.198 and so the null hypothesis was accepted and it was concluded that there was no significant difference between staff age and base. The SPSS package computes the significance level, and in this case it was .060. Since this was greater than .05, it confirmed that the null hypothesis should be accepted.

(The process described above was followed in all cases where ANOVA was to be applied.)

4.3.2.2. Work experience

Logically, the quality of practice of practitioners should improve with years of experience. However, this is not always so. As elaborated upon in Chapter Two, 2.11, studies have shown that senior staff lead by example. Junior staff are likely to follow an incorrect example set by their mentors, thus possibly leading to poor IC practices and procedures. It was thus necessary to look for correlations between work experience and knowledge and practice.

The average length of work experience was 7.06 years. The least work experience was 4 months, and the most was 27 years. Of the 122 staff members who participated in the survey, four did not indicate their work experience.

Table 7: Descriptive statistics for number of years worked by base

Base code	Mean	N	Std. Deviation	Std. Error of Mean
Base A	6.046	46	6.4946	.9576
Base B	12.082	28	8.4009	1.5876
Base C	6.069	13	6.4127	1.7786
Base D	3.417	12	3.5698	1.0305
Base E	4.877	13	5.6905	1.5783
Base F	5.633	6	5.4997	2.2452
Total	7.064	118	7.1473	.6580

When the bases were compared in terms of the amount of years worked by staff, Base B had the highest mean of 12.08 years (see Table 7). However, it also had the highest SD (8.40). In fact, there was a marked variation in the mean number of years worked across the bases. To determine whether there was significant difference, ANOVA was conducted. The significance for Levene's test was .002, therefore it was appropriate to use ANOVA. The significance level for ANOVA (with df = 5 and 112) was .001. Since this was < .05, it was concluded that there was a significant difference in the number of years worked by staff for each base.

4.3.2.3. Qualification

As mentioned in Chapter Two, 2.10., ambulance staff have three qualification levels based on their education and training. These qualifications inform their scope of practice. This scope of practice spans basic life support skills to advanced invasive therapies as outlined in Chapter Two, 2.3. This was an important variable, as it could influence the knowledge and practices of staff. In addition, it is logical to conclude that a concomitant increase in the risk of HCAIs has accompanied this enlarged scope of practice.

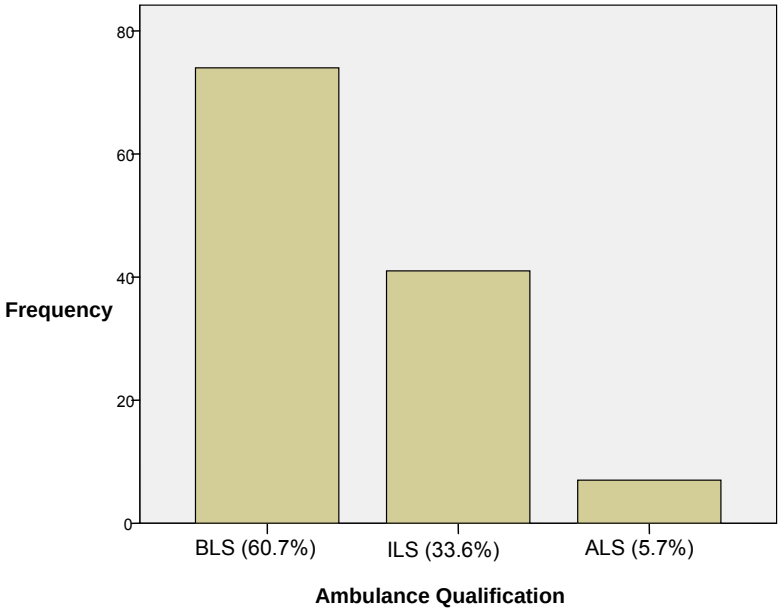

Figure 3: Distribution of ambulance qualification

It is readily apparent from Figure 3, that the majority of the staff were Basic Life Support (BLS) trained while 33.6% were qualified at Intermediate Life Support level (ILS). Only 5.7% of the staff were at Advanced Life Support level (ALS). None of the staff indicated that they held other qualifications.

Table 8: Crosstabulation of age by level of qualification

Qualification		Age categories				Total
		25 - 29	30 - 34	35 - 39	40 - 44	
BLS	Frequency	31	18	7	4	60
	% within	86.1%	72.0%	36.8%	25.0%	62.5%
ILS	Count	4	7	9	10	30
	% within	11.1%	28.0%	47.4%	62.5%	31.3%
ALS	Count	1	0	3	2	6
	% within	2.8%	.0%	15.8%	12.5%	6.3%
Total	Count	36	25	19	16	96
	% within	100.0%	100.0%	100.0%	100.0%	100.0%

Crosstabulations were performed between levels of qualification and staff age. As can be seen in Table 8, most BLS staff fell into the younger age categories, whilst the converse was true for the ILS staff. The age categories varied for ALS staff, but this is also a reflection of the small number in this sub-sample (n = 6).

Since the BLS qualification is an entrance into the EMS profession, it is expected that they would be younger. ILS staff tend to progress rapidly from BLS to ILS, and tend to remain longer at this level, as ALS short-course training is expensive and seldom offered by ambulance training colleges. Access to tertiary ALS education is limited, in that these are full time courses. It is not possible to comment on the ALS staff and age distribution, as they consist of a small sub-sample size. .

The Kruskal Wallis test was performed to determine whether the variations in age by qualification were statistically significant. This test was selected because both of the variables were measured at the ordinal level. The test result was 24.544, with df = 3 and significance .000. Therefore, since this was < .05, the null hypothesis was rejected and it was concluded that there was a significant difference in the ages of respondent in relation to qualification.

4.3.3. Infection control policies and procedures

As part of a generic IC programme, policies and procedures for preventing / controlling the transmission of infectious agents; employer education, and infection control aspects of employee health need to be in place. Further detail regarding these policies and procedures are outlined in Chapter Two, 2.7. In South Africa, generic policies and procedures for IC are covered under the Regulations for Hazardous Biological Agents (South Africa, 2001).

In order to ascertain whether policies and their associated procedures were in use in this study setting, the staff were asked if policies and procedures for IC existed. Of the 121 staff members who responded, 56 (45.9 %) of the staff indicated that there were, and 65 or 53.27% said that they did not exist. It must be noted that 19 (15.6%) of staff members who were not sure if policies and procedures existed, were included in the group that indicated that they did not exist (see Table 9).

Table 9: Are there policies and procedures on IC at your workplace?

Response		Frequency	Percent	Cumulative Percent
Valid	Yes	56	45.9	45.9
	No	46	37.7	83.6
	Do not know	19	15.6	100
	Total	121	99.2	
Missing	Unanswered	1	.8	
Total				

When asked whether they were sufficiently informed about policies and procedures regarding IC, 84 (68.9%) of them said that they were not. Only 37 (30.3%) agreed that they were sufficiently informed (Table 10).

Table 10: Do you feel that you were sufficiently informed about these policies and procedures on IC

Response		Frequency	Percent	Cumulative Percent
Valid	Yes	37	30.3	30.3
	No	84	68.9	100.0
	Total	121	99.2	
Missing	Unanswered	1	.8	
Total		122	100.0	

In order to further explore this issue, a crosstabulation of the two questions were performed (see Table 11). It is notable that of the 56 (45.9%) who indicated that there were policies and procedures in place, 27 (49.1%) of them stated that they were not sufficiently informed about them. It was also noted, that only 28 (50.9%) of the respondents, who indicated that there were policies and procedures stated that they were informed about them.

Table 11: Crosstabulation: Existence of IC policies and procedures and adequacy of information on IC policies and procedures

			Adequacy of information on IC policies and procedures		Total
			Yes	No	Yes
Existence of IC policies and procedures	Do not know	Count	3	16	19
		% within	15.8%	84.2%	100.0 %
	Yes	Count	28	27	55
		% within	50.9%	49.1%	100.0 %
	No	Count	5	41	46
		% within	10.9%	89.1%	100.0 %
Total		Count	36	84	120
		% within	30.0%	70.0%	100.0 %

This was further investigated by determining the level of qualification of this subset of respondents. It was noted that 21 or 75% of the BLS staff indicated that policies and procedures were in place and that they were sufficiently informed about them. This is inconsistent with the fact that this author was unable to locate any policies and procedures on IC. This was further substantiated by the majority of staff who indicated the same. A possible reason for this, is that the BLS staff had limited work experience generally, and poor knowledge on IC. They may have responded to these questions from an uninformed perspective. To further substantiate this reasoning, of the 29 BLS staff that indicated that there were no policies and procedures in place and of the 15 that indicated that they were not sure, 8 indicated that they were sufficiently informed about them.

In essence, most of the respondents were unaware of IC policies and procedures, and even if they did believe they existed, most felt they needed more information on them. This is a cause for concern, as it has clearly been shown that in many first world countries, where sound IC programmes are in place, the incidences of HCAIs are low (Pearse, 1997). Well structured IC programmes play a vital role in reducing mortality, morbidity and costs to both the patients and health care system. Without policies and procedures, an IC programme cannot be regarded as being well-structured and effective. Furthermore, the Regulations for HBAs (South Africa, 2001) require that where workers are exposed to biological agents, information and instructions must be given to them or set out on notices displayed in the workplace. Such information should be contained in the policies and procedures of an organization. This researcher did not notice, and was unable to locate any IC policies and procedures during base visits.

4.3.4. Education and training

An overwhelming majority of ambulance staff (107 or 99.1%) indicated that they were interested in learning more about IC. The staff were questioned further as to what aspects they would like to learn more about, and the following topics were indicated:

- IC in general (58 or 47, 5%);
- information on pathogenic micro-organisms (22 or 18%); and
- types and use of disinfectants (5 or 4.1%).

Of all the possible respondents, 37 (30.3%) did not answer this question.

Crosstabulations were performed, to find relationships between IC aspects that staff would like to learn more about and their qualification levels. As can be seen in Table 12, the quest for further education in all aspects were similar for all qualification levels.

Table 12: Crosstabulation: ambulance qualification by what aspects of IC staff would like to learn more about

		What aspects of IC would you like to learn more about?				Total
Qualification		IC in general	Types of disinfectant	Information on pathogens	Unanswered	IC in general
BLS	Count	37	2	11	24	74
	% within	50.0%	2.7%	14.9%	32.4%	100.0%
ILS	Count	18	2	9	12	41
	% within	43.9%	4.9%	22.0%	29.3%	100.0%
ALS	Count	3	1	2	1	7
	% within	42.9%	14.3%	28.6%	14.3%	100.0%
Count		58	5	22	37	122
% of Total		47.5%	4.1%	18.0%	30.3%	100.0%

The fact that most of the respondents desired more information on IC is encouraging, and yet it is a cause for concern, as it is an indication of the lack of training being given on this aspect. Initial and refresher training and education are vital to ensure a successful IC programme (ASA, 2004; Houng and Hurley, 1996; Mehtar, 1995; USFA, 2002). Nigam and Cutter (2003) reported that a lack

of IC education was a possible reason for the contamination of the ambulances in their study. Staff must be educated on safe working procedures and occupational risks to their health, particularly in respect of transmission of infection. The Regulations for HBAs (South Africa, 2001) state that an employer shall, before any employee is exposed or may be exposed, ensure that the employee is adequately and comprehensively informed and trained on both the practical aspects and theoretical knowledge with regard to HBAs as stipulated in the act.

4.3.5. Staff members' knowledge of infection control

4.3.5.1. Analysis of questions on knowledge

In order to test staff knowledge on IC, six questions were asked to assess the respondents' knowledge on basic aspects of IC, relevant for ambulance services. The first two questions were open-ended, whilst the remainder were closed-ended questions. Their results, in terms of their actual answers, appear in Tables 13 and 14.

Table 13: Questions on detergents and disinfectants

What is a detergent used for?	**Frequency**	**Percentage**
To clean the ambulance	22	18
To clean the ambulance and it's equipment	27	22.1
To kill germs	7	5.7
To disinfect	5	4.1
Unsure	27	22.1
Unanswered	34	27.9
Total	122	100
What is a disinfectant used for?	**Frequency**	**Percentage**
To kill germs	39	32
To remove germs	8	6.6
To sterilize equipment	7	5.7
To clean the ambulance and medical equipment	19	15.5
Unsure	18	14.8
Unanswered	31	25.4
Total	122	100

Of all the staff who answered the question on the use of detergents and disinfectants, 50% and 59.8% were partially correct, respectively.

Table14: Questions on IC knowledge

Responses to questions on knowledge	Yes		No		Unsure		Unanswered		Total	
	n	%	n	%	n	%	n	%	n	%
Can germs pass through latex gloves?	52	42.6	57	46.7	6	4.9	7	5.7	122	100
Can you contract infections while working in ambulances?	110	90.2	3	2.5	9	7.4	0	0	122	100
Can germs live in dried blood for up to six months?	60	49.2	24	19.7	37	30.3	1	0.8	122	100
Can you be infected from a needlestick injury?	117	95.9	2	1.6	3	2.5	0	0	122	100

The answers to the questions in Table 14, were generally poor. Only two questions were well answered. Alarmingly, 57 or 46.7% of the staff believed that germs could not pass through latex gloves (see Chapter Two, 2.8.2.4.) and only 60 or 49.2% of staff thought that germs could live in dried blood for up to six months (see Chapter Two, 2.8).

Crosstabulations were performed to investigate relationships between staff qualification and answers that they provided.

Table15: Qualifications of staff who answered the use of detergents and disinfectants incorrectly (%)

Qualification	Detergent	Disinfectant
BLS	63,5%	51.4%
ILS	31.8%	26.8%
ALS	14.3%	0%

With respect to the first two questions, the number of those questions which were unanswered or for which respondents said they were unsure, were added to produce a percentage of completely incorrect answers (Table 15). As can be seen, the staff with lower levels of training had a corresponding increase in incorrect answers for both questions.

Table 16: Responses to knowledge questions by qualification

Qualification		No %	Unsure %	Yes %	Total %
Basic Life Support	Can germs pass through latex gloves?	52.9	4.4	42.6	100.0
	Is it possible to become infected when you are working on an ambulance?	2.7	9.5	87.8	100.0
	Is it possible for germs to live in dried blood for up to six months?	26.0	32.9	41.1	100.0
	Chance of being infected when a needle that has been used on a patient, penetrates your skin?	2.7	2.7	94.6	100.0
Intermediate Life Support	Can germs pass through latex gloves?	50.0	5.0	45.0	100.0
	Is it possible for you to become infected when you are working on an ambulance?	2.4	4.9	92.7	100.0
	Is it possible for germs to live in dried blood for up to six months?	9.8	31.7	58.5	100.0
	Is there a chance of being infected when a needle that has been used on a patient, penetrates your skin?		2.4	97.6	100.0
Advanced Life Support	Can germs pass through latex gloves?	14.3	71.4	14.3	100.0
	Possible for you to become infected when you are working on an ambulance?			100.0	100.0
	Is it possible for germs to live in dried blood for up to six months?	14.3		85.7	100.0
	Is there a chance of being infected when a needle that has been used on a patient, penetrates your skin?			100.0	100.0

Table 16, represents the distribution of the other four knowledge questions as related to ambulance qualification. As expected, the ALS staff fared better. Of note is that most did know that they could become infected while working on an ambulance and as a result of a needlestick injury, which means that they were aware of the risks associated with their job. However, their knowledge regarding the other two questions was poor. As mentioned in Chapter Two, 2.10, staff must be educated on safe working procedures and occupational risks to their health, particularly in respect of transmission of infection.

4.3.5.2. Staff members' knowledge score

As mentioned in Chapter Two, 2.11, knowledge is a basis of good and well informed practice, although adequate knowledge does not necessarily equate to better practice. An assessment rubric was designed to quantify the ambulance staffs' knowledge in ambulance IC (see Annexure 10).

Table 17: Number of scores that were completely correct for knowledge questions

Knowledge questions	Correct	Incorrect
What is a detergent?	2 (1.6%)	120 (98.4%)
What is a disinfectant?	0	122 (100%)
Can germs pass through latex gloves?	58 (47.5%)	64 (62.5%)
Infection risk from working in ambulances	113 (92.6%)	9 (7.4%)
Can germs live in dried blood for 6 mths?	58 (47.5%)	64 (52,5%)
Can you get infection from a needlestick injury?	121 (99.2%)	1 (.8%)

As can be seen from Table 17, the scores are poor. Although the questions were limited in number and basic, it gives an indication as to current levels of knowledge. It also accords with the responses for Question 7, which indicated that 99.1% of staff would like to know more about IC.

The scores for each of these six questions were calculated as percentage scores, and were then combined to produce a knowledge score expressed as a percentage. The average knowledge score was 31.57% for the district as a whole.

4.3.6. Ambulance decontamination routine

As mentioned in Chapter Two, 2.8.2.1, decontamination is the physical or chemical process of reducing and preventing the spread of hazardous biological materials by persons or equipment (NFPA, 2005). A decontamination programme has three levels comprising of cleaning, disinfection and sterilization.

In this study, the word “clean” (in the IC context) means to “decontaminate”. As elaborated upon in Chapter Three, these terms were changed in order to avoid confusion. A definition for the word “clean” was provided for at the beginning of the questionnaire. The following results and discussion attempted to evaluate ambulance cleaning in this study setting.

4.3.6.1. Assessing cleaning times and reasons for doing so.

Table 18, is a summary of the participant’s responses as to when ambulances are usually cleaned. The staff were describing what usually happened with respect to ambulance cleaning at the base and not what they personally would like to do.

Table 18. When are the ambulances at your base usually cleaned?

Responses		Frequency	Percent
	After every case	6	4.9
	Only when dirty	24	19.7
	End of shift	38	31.1
	End of shift or after a particularly dirty case	50	41.0
	Total answered	118	96.7
	Unanswered	4	3.3
Total		122	100.0

It is clear that the frequency with which ambulances were cleaned was determined by events (e.g. after a case) and times (e.g. at the end of the shift). Just over half the sample (68 or 55.74%) gave only one determinant. However, 50 (41%) gave more than one response, i.e. at the end of the shift or after a

particularly dirty case. As mentioned in Chapter Two, universal ambulance decontamination protocols recommend daily and in-between patient cleaning. A comprehensive clean should take place once a week.

At the time of the investigation, the majority of the staff (74 or 60.7%) indicated that ambulances were cleaned when 'dirty'. Questioning them on this term revealed that a 'dirty case' was one that involved body fluid spillage. This was appropriate as it is essential that disinfection of spillages of blood and body fluids be carried out promptly as viruses such as HIV and hepatitis B have been found to survive in blood for weeks or months (Nigam and Cutter, 2003).

The participants were questioned further regarding the reasons for cleaning at the times indicated in Table 18. Their responses appear below.

Of the six (or 5.1%) staff members that stated the ambulances were cleaned after every case, five of them indicated the reason as being to prevent cross infection. One staff member did not give a reason.

Table 19: Reason for cleaning 'Only when dirty'

Reasons given	Frequency	Percent
Not enough time due to outstanding calls	15	**62.5**
In order to handover a clean vehicle to the oncoming shift	1	**4.1**
To prevent cross-infection	2	**8.3**
No reason given	6	**25**
Total	24	**100**

Of the 24 (19.7%) staff that stated that ambulances were cleaned only when dirty, 15 gave the reason for them not being cleaned more frequently as insufficient time due to outstanding calls.

The motivation to only clean the ambulance when dirty seems to be in response to visible dirt eg. blood and excrement. It is possible that staff perceive a risk of the spread of disease and the need for cleaning only when they see a threat, eg. blood. In this survey, when asked whether it was possible to contract infectious diseases while working in an ambulance (see table 14), 110 (90.2%) of the staff

responded yes - so most of them do appear to be aware of some risk. However, as Houang and Hurley (1997) note, knowledge of the risk alone is not sufficient to motivate correct behaviour. In this study, it seems that not having enough time to clean due to the high case load, is the main reason for poor cleaning practices.

Thirty eight (31.1%) of respondents indicated that ambulances were cleaned at the end of the shift. The reasons for this appear in Table 20. In addition, 50 (41%) stated that they were either cleaned at the end of the shift or after a particularly dirty case (see Table 21).

Table 20: Reason for cleaning: 'End of shift'

Reasons given	Frequency	Percent
Not enough time due to outstanding calls	14	**36.8**
In order to handover a clean vehicle to the oncoming shift	14	**36.8**
To prevent cross-infection	4	**10.5**
No reason given	6	**15.7**
Total	38	**100**

Table 21: Reason for cleaning: 'End of shift or after a particularly dirty' case

Reasons given	Frequency	Percent
Not enough time due to outstanding calls	24	**48**
In order to handover a clean vehicle to the oncoming shift	11	**22**
To prevent cross-infection	10	**20**
No reason given	5	**10**
Total	50	**100**

Based on the collective responses in these two tables, it is clear that 38 gave the reason as “not enough time due to outstanding calls”.

In this survey, of the 88 ambulance staff that reported that they cleaned their vehicles at the “end of shift only”; and at the “end of shift or after a particularly dirty case”, only 14 (15.9%) reported that they cleaned in order to prevent disease. These were BLS and ILS trained staff members.

As already noted, the main reason given for only cleaning at these times, was “not enough time due to high case loads”. The amount of time available for cleaning the ambulance before the next emergency call out is a critical factor in the level of attention that an ambulance would receive.

Another compelling reason for cleaning at the end of the shift, was to handover a clean vehicle to the oncoming shift. Twenty five respondents gave this as a reason. In most instances, the only time available for staff to return to the ambulance base is during shift change-over. From the researcher's own experience, the staff normally give the ambulance a quick clean as they are in a hurry to go home after a tiring 12 hour shift. Cleaning is often rushed and not performed thoroughly at or around crew change, as the out-going staff are reluctant to assist on a possible "late" call, which may come in while they are busy cleaning the ambulance. Cleaning is thus performed inefficiently, judging from the high levels of bacterial contamination in this study, and is primarily done in order to handover a presentable looking vehicle to the oncoming shift. The ambulance looks clean as only visible dirt is removed.

It can be deduced from the participant's responses, that at the time of the investigation, there seemed to be no standardized cleaning schedule in any of the bases. The frequency of cleaning seems to depend on the perception of risk and the availability of time. The latter reason is understandable, since as mentioned in Chapter Two, 2.8.2.3, no emergency or urgent call should ever be delayed as a result of a vehicle being washed or cleaned. However, routine, effective vehicle cleaning should take place after transport of every patient if possible and always at the end of the shift. Only six staff members indicated that they cleaned after transport of every patient. Both the ASA (2004) and the USFA (2002) ambulance cleaning guidelines recommend the daily cleaning of ambulances. The guidelines also state that if operational demands sometimes restrict regular end-of-shift cleaning, it must be done as soon thereafter as is convenient.

In Table 22, it can be seen that 43.4% (53) of staff in the entire district indicated that there was not sufficient time to clean. A further 32.8% (40) indicated that having sufficient time to clean only happened sometimes. This is a cause for concern as routine ambulance cleaning is a matter of great importance.

4.3.6.2. Sufficient time for cleaning

Table 22 : Do you have sufficient time to clean your ambulance?

Response	Frequency	Percent
No, never	53	43.4
Sometimes	40	32.8
Yes, always	28	23.0
Total	121	99.2
Unanswered	1	.8
Total	122	100.0

It is interesting to note that an unexpectedly high number (n=28) of staff members indicated that they always had time to clean their ambulances. This was contrary to what the majority of staff indicated, and this warranted further investigation. It was initially thought that these respondents were from the rural bases and since call rates tend to be lower at the rural bases, staff would have more time to clean.

A crosstabulation was done to investigate the distribution of the respondents according to base, as can be seen in Table 23.

Table 23: Crosstabulation: Do you have sufficient time to clean your ambulance?

		Do you have sufficient time to clean your ambulance?			Total
Ambulance base		No, never	Sometimes	Yes, always	No, never
Base	Base A	18 (37.5%)	18 (37.5%)	12 (25%)	48 (100%)
	Base B	10(34.45%)	11 (37.93)	8 (27.58%)	29 (99.96%)
	Base C	9 (69.23%)	2 (15.38%)	2 (15.38%)	13 (99.99%)
	Base D	6 (50%)	3 (25%)	3 (25%)	12 (100%)
	Base E	9 (69.23%)	2 (15.38%)	2 (15.38%)	13 (99.99%)
	Base F	1(16.66%)	4 (66.66%)	1 (16.66%)	6 (99.98%)
Total		53	40	28	121

It was noted that 25% of staff from base A and 27.5% of the staff from base B reported that there was sufficient time for ambulance cleaning. Ambulance base A and B service the more urbanized areas of the study district. These responses are proportionately higher than for the other more rural bases. From this crosstabulation, it can be seen that the assumption of ambulance staff from the

rural bases having more time to clean their ambulances does not appear to be correct.

The Kruskal Wallis test was performed to determine whether the variations in ambulance base by sufficiency of time to clean the ambulance were significantly different. This test was selected because both of the variables were measured at the ordinal level. The significance was .202. Therefore, since this was > .05, the null hypothesis was accepted, and it was concluded that there was no significant difference between the ambulance bases as far as sufficiency of time to clean the ambulance was concerned.

A crosstabulation was done to investigate the distribution of the respondents according to qualification and by sufficient time to clean the ambulance. It was found that all 28 respondents who indicated that there always was sufficient time to clean the ambulance, were BLS trained. As mentioned elsewhere in the text, a possible reason for this, is that the BLS staff had limited work experience generally, and poor knowledge on IC. They may have indicated that they always had sufficient time to clean, simply because they do not know better.

The Kruskal Wallis test was performed to determine whether the variations in qualifications and sufficient time to clean the ambulance was significantly different. The test result was .005. Therefore, since this was < .05, the null hypothesis was rejected and it was concluded that there was a significant difference in the qualifications of the respondents and their responses regarding sufficient time to clean the ambulances.

4.3.6.3. Assessing patient-equipment cleaning times

The responses, as to when equipment (eg. BP cuff and stethoscope) that was used on patients are usually cleaned are summarized in Table 24. The majority responded that the equipment was cleaned only when dirty; thus implying that it had to be visibly dirty before it would be cleaned. However, it was encouraging to note that 49 (40.2%) indicated that it was cleaned after every case – which was

the correct practice. As mentioned in Chapter Two, 2.8.3, routine vehicle cleaning should take place after transport of every patient if possible. The reasons why staff cleaned at these times were not investigated.

Table 24: When is equipment that has been used on patients usually cleaned?

Response	Frequency	Percent
After every case	49	40.2
Only when dirty	61	50.0
End of shift	9	7.4
Total	119	97.5
Unanswered	3	2.5
Total	122	100.0

The Kruskal Wallis test was performed to determine whether the variations in qualification of the respondents reporting the times when patient equipment was usually cleaned, were statistically significant. The test result was .097. Since this was > .05, the null hypothesis was accepted and it was concluded that there was no significant difference in qualifications and the times when patient equipment was usually cleaned.

A crosstabulation was done to investigate when patient equipment was usually cleaned at the different ambulance bases (Table 25). The times varied across the district.

In order to determine whether the variations in ambulance base by times when patient equipment was usually cleaned, was statistically significant, the Kruskal Wallis test was performed. The test result was .023. This was < .05, thus the null hypothesis was rejected and it was concluded that there was a significant difference in ambulance bases and the times when patient equipment was usually cleaned.

Table 25: Crosstabulation: when is equipment that has been used for patients usually cleaned? * Base code

			Base code						Total
			Base A	Base B	Base C	Base D	Base E	Base F	
When is equipment that has been used for patients usually cleaned?	After every case	Count	21	13	9	4	1	1	49
		% within	45.7%	44.8%	69.2%	33.3%	7.7%	16.7%	41.2%
	Only when dirty	Count	24	12	4	6	10	5	61
		% within	52.2%	41.4%	30.8%	50.0%	76.9%	83.3%	51.3%
	End of shift	Count	1	4	0	2	2	0	9
		% within	2.2%	13.8%	.0%	16.7%	15.4%	.0%	7.6%
Total		Count	46	29	13	12	13	6	119
		% within	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

4.3.6.4 Conclusion

As mentioned in the literature study, routine ambulance cleaning should take place daily and after transport of every patient if possible. All ambulance interiors should be subjected to a comprehensive clean on a weekly basis. It is evident from the results and their interpretation above, that ambulance cleaning in this study setting is inadequate. This is also evident from the widespread microbial contamination levels of ambulances outlined in Objective One of this study.

4.3.7. Methods for decontaminating the ambulance and it's equipment

4.3.7.1. The ambulance patient compartment

A number of questions were designed to ascertain methods of general ambulance cleaning practices and procedures. The tables below summarize the staff member's responses.

Table 26: How is the ambulance patient compartment usually cleaned?

Method of cleaning		Frequency	Percent
Valid	With water	28	23.0
	Soap and water	74	60.7
	Soap, water and disinfectant	16	13.1
	Disinfectant only	1	.8
	Total	119	97.5
	Total unanswered	3	2.5
Total		122	100.0

As is mentioned in Chapter Two, 2.8.2.1, cleaning with hot water and detergent will remove soil, organic material, micro-organisms and bacterial spores from surfaces. Although the majority of staff in Table 26, indicated that they used soap and water; or soap, water and disinfectant to clean the patient compartment, samples of swabs taken from the patient compartment, namely stretcher mattresses, stretcher rails and both settle plates, showed significant microbial contamination.

Crosstabulations were conducted to look for relationships between ambulance bases and how their respective ambulance patient compartments were usually cleaned. Methods of cleaning did not appear to vary much across the district under study. This was confirmed by the Kruskal Wallis test ($p = .869$). The null hypothesis was therefore accepted and it was concluded that there was no significant difference between ambulance bases and how the ambulance patient compartment was usually cleaned.

4.3.7.2. The ambulance driver compartment

Table 27: How is the ambulance driver compartment usually cleaned?

Method of cleaning		Frequency	Percent
Valid	With water	39	32.0
	Soap and water	66	54.1
	Soap, water and disinfectant	12	9.8
	Total	117	95.9
	Total unanswered	5	4.1
Total		122	100.0

As can be seen in Table 27, an alarmingly high number of staff, 39 (32%) used water only to clean the ambulance driver compartment. Although 66 (54.1%) of the staff indicated that they cleaned the inside of the driver compartment with soap and water, both the steering wheels and seatbelts showed significant microbial contamination. Soap, water and disinfectant were used by 12 (9.8%) of the staff to clean the ambulance driver compartment. Staff may feel that the driver compartment is less of a disease threat compared to the patient compartment. This may explain the poorer standards in the cleaning of the driver compartment.

Crosstabulations were used to look for relationships between ambulance bases and how their ambulance driver compartments were usually cleaned. Bases A, C, D and F seemed to perform better, as the majority of the staff at these bases used soap and water, or soap, water and disinfectant to clean.

Crosstabulations were performed to look for relationships between cleaning of the ambulance patient compartment and driver compartment. In total, 33.6% of staff used water only to clean both compartments, compared to 56.9% who used soap and water to clean both compartments. The high contamination level of both these compartments suggests that what is reported is not necessarily what is practiced.

The above crosstabulations were taken further, to find out if there were any relationships between staff qualification and cleaning of the driver and patient compartments. The BLS staff reported better practices compared with the respondents of other levels of qualification in that 27.1% used water only, to clean both compartments, compared to 46.2% of ILS and 28.6% of ALS staff. The use of soap and water to clean both compartments were indicated by 62.9% of BLS staff, compared to 43.6% of ILS and 71.4% of ALS staff. A possible reason for better cleaning practices of ALS staff is their higher level of training. However, as there were only seven in the study, this may have been due to chance variations.

The Kruskal Wallis test result was .027, confirming that there was a significant difference between ambulance qualification and how the ambulance patient compartment was usually cleaned. However, there was no significant difference between ambulance qualification and how the ambulance driver compartment was usually cleaned (Kruskal Wallis p = .207).

To partially test the null hypothesis that the knowledge and practices of staff in ambulance IC will not differ at the different bases in the district, the Kruskal Wallis test was performed to determine whether the variations in ambulance bases by cleaning practices for the patient, and driver compartments were statistically significant. The results are as follows:
Ambulance base and patient compartment cleaning practices result was 1.853, with df = 5 and significance .869.

Ambulance base and driver compartment cleaning practices result was 7.066, with df = 5 and significance .216.

The null hypothesis was therefore partially accepted, and it was concluded that there are no significant differences.

4.3.7.3. The patient equipment

Table 28: How is the patient equipment usually cleaned?

Method of cleaning		Frequency	Percent
Valid	With water	27	22.1
	Soap and water	67	54.9
	Soap, water and disinfectant	20	16.4
	Disinfectant only	3	2.5
	Total	117	95.9
	Total unanswered	5	4.1
Total		122	100.0

As with the other sites within ambulances, adequate cleaning of patient equipment did not take place. This is evidenced by the fact that samples of swabs taken from the patient medical equipment, namely the suction units, humidifiers, stethoscopes and BP cuffs, demonstrated significant microbial contamination.

The Kruskal Wallis test result was performed to determine whether the variations in ambulance staff qualification and how the patient equipment was usually cleaned, were statistically significant. The test result was p = .369. It was therefore concluded that there are no significant differences.

To partially test the null hypothesis that the knowledge and practices of staff in ambulance IC will not differ at the different bases in the district, the Kruskal Wallis test was performed to determine whether the variations in ambulance bases by how patient equipment was usually cleaned, were statistically significant. The result was 12.217, with df = 5 and significance .032. The null hypothesis was rejected, therefore there was a significant difference.

As is evidenced in Chapter Two, 2.5, the chain of transmission of infection is broken when there is an interruption at one or more of the links. Effective ambulance cleaning prevents the spread of the agents which may cause diseases (EHSB, 2007). Any decontamination programme has three levels comprising cleaning, disinfection and sterilization, however in an ambulance service, cleaning an disinfection are relevant.

The above tables summarize the data for the questions that indicate general ambulance cleaning methods. A large percentage of staff used water only to clean the ambulance patient compartment (see Table 26), the driver compartment (see Table 27) and patient equipment (Table 28). As mentioned by the USFA (2002) and ASA (2004) ambulance IC guidelines, water itself is not adequate for proper decontamination. Water alone cannot remove organic material effectively. Organic material or dirt forms a protective coat over micro-organisms, thus preventing disinfectants from working properly. A detergent is thus needed to remove organic material before disinfection.

Soap and water removes organic material efficiently and is adequate on it's own in removing most micro-organisms. As can be seen in Tables 26, 27, and 28, an average of 56.5% of the staff indicated that they used soap and water for general cleaning of the ambulance. Disinfectant is still needed in areas of high contamination eg body fluid spillage.

In this study, the responses seem to indicate that those staff that used disinfectants only (n=5), did so for general cleaning. Disinfectants, if used without water and detergent, can be ineffective in removing micro-organisms. Water and detergents are needed, as disinfectants may not be able to get to micro-organisms because dirt may form a protective coat.

An average of only 18.5% staff members in this study indicated that they used soap, water and disinfectant, when available, for general ambulance cleaning. This method of cleaning is adequate in preventing and controlling agents that spread disease (Pearse, 1997).

The ineffectiveness of the cleaning methods was evidenced by the high levels of microbial contamination, in particular, with C*oliform* and P*seudomonas* sp. found at the various sites sampled, as is summarized below.

Table 29: The patient compartment sites and quantity per species identified.

Microbes (n)	Stretcher Mattress	Stretcher Rails	Settle Plate: front	Settle Plate: rear
Klebsiella sp.	1	3	1	2
Pseudomonas sp.	6	6		2
*Aspergergillu*s sp.		1		
E. cloacae.	2			
Enterobacter sp.				1
*Citrobacte*r sp.	2	1		

Table 30: The driver compartment sites and quantity per species identified.

Microbes (n)	Seatbelt	Steering wheel
*Klebsiell*a sp.	1	4
Pseudomonas sp.	7	5
P. *aeruginosa*	1	
E. coli	1	
Enterobacter sp.	3	
Citrobacter sp.	1	1

Table 31: The patient equipment sites and quantity per species identified.

Microbes (n)	Oxygen taps	Suction unit	Humidifier*	Stethoscope	BP cuff
E. coli	1				3
*Klebsiell*a sp.		1	2		
Pseudomonas sp.	8	12	7	4	4
Enterobacter sp.	1				
E. cloacae.	2	1	2	1	1

*Should be disposed of after single use

4.3.74. The cleaning equipment

Table 32: How is cleaning equipment usually cleaned?

Method of cleaning		Frequency	Percent
Valid	With water	49	40.2
	Soap and water	52	42.6
	Soap, water and disinfectant	16	13.1
	Disinfectant only	1	.8
	Total	118	96.7
	Total unanswered	4	3.3
Total		122	100.0

In addition to adequate cleaning methods, proper decontamination of cleaning equipment should take place. Contaminated cleaning equipment may be blamed for the spread of micro-organisms (Nigam and Cutter, 2003). In this study, 49 (40.2%) of the staff used water only to decontaminate cleaning equipment (Table 32). Furthermore, as can be seen from Table 33, 94 (77%) of the staff indicated that they shared cleaning equipment, and a further 20 (16.4%) reported that cleaning equipment was shared some of the time. There was no significant difference between the reported methods of cleaning and the qualifications of respondents.

To partially test the null hypothesis that the knowledge and practices of staff in ambulance IC will not differ at the different bases in the district, the Kruskal Wallis test was performed to look for significance of variance between ambulance bases, and how cleaning equipment was usually cleaned. The score was .033, therefore the null hypothesis is partially rejected.

Table 33: Is cleaning equipment shared between ambulances?

Response		Frequency	Percent
Valid	No, never	6	4.9
	Sometimes	20	16.4
	Yes, often	94	77
	Total	120	98.4
	Total unanswered	2	1.6
Total		122	100.0

Without observation studies to verify staff cleaning methods, staff compliance with accepted cleaning methods is likely to be overestimated, as mentioned in a survey conducted by Houang and Hurley (1997). Based on this, it is possible that the responses to the questions on cleaning methods may have overstated the level of cleaning and it may be that the standard of practices is even lower than reported. This speculation is supported by the high microbial contamination levels found in this study.

Although all staff have an individual responsibility to keep the ambulance clean and thus reduce the risk of cross infection to themselves, their colleagues and their patients (USFA, 2002; ASA, 2004), adequate ambulance decontamination cannot be carried out if staff are lacking resources and support from management. As mentioned in Chapter Two, 2.3, one of the essential requirements for effective cleaning is the ready availability of cleaning equipment. In this study, 45 (36.9%) staff members indicated that it was never available and 58 (47.5%) said it was only available sometimes (Table 34).

4.3.7.5. Availability of cleaning equipment

Table 34: Is cleaning equipment readily available?

Response		Frequency	Percent
Valid	No, never	45	36.9
	Sometimes	58	47.5
	Yes, always	18	14.8
	Total	121	99.2
	Total unanswered	1	.8
Total		122	100.0

A possible reason why such a high percentage of respondents used water only to clean both the patient and drivers' compartments and only 9.5% used soap, water and disinfectant for cleaning both compartments, could be the unavailability of cleaning equipment (Table 34).

The 18 staff members who indicated that cleaning equipment was always available, contradicted what the rest of the staff in the district indicated. This warranted further investigation. Crosstabulations were performed to look for relationships between staff qualification and responses to the question on the availability of cleaning equipment. Once again, the BLS staff seemed to be the outliers. All 18 respondents who indicated that cleaning equipment was always available were BLS qualified. A possible reason for this, is that these staff members may have limited work experience generally, and poor knowledge on IC. They may not be aware of what constitutes ambulance cleaning equipment.

Crosstabulations were performed to look for relationships between ambulance bases and the availability of cleaning equipment. The responses were generally the same across the district. This was confirmed by the Kruskal Wallis test (p = .323) indicating that the variations in ambulance bases by the availability of cleaning equipment, were not statistically significant.

As can be seen from Table 35, when asked whether management performed regular checks to ensure that proper cleaning and disinfection of ambulances took place, 89 (73%) said “no never” and 26 (21.3%) said “sometimes”.

4.3.7.6. Quality assurance by management

Table 35: Is cleaning of ambulances regularly checked by management?

Response		Frequency	Percent
Valid	No, never	89	73
	Sometimes	26	21.3
	Yes, always	6	4.9
	Total	121	99.2
	Total unanswered	1	.8
Total		122	100.0

Crosstabulations were performed to look for relationships between regular cleaning checks by management and the responses from the different bases. There was little variation in the responses, again confirmed by the Kruskal Wallis test ($p = .336$).

In order to find out which staff members indicated that ambulance cleaning was always checked by management, crosstabulations were performed. It was found that all these respondents were BLS qualified. As mentioned earlier on in the text, these staff members may have been newly recruited with limited work experience. They may also be unaware of all the roles of management.

4.3.8. Ambulance cleaning scores, staff age and work experience

The cleaning scores of respondents by actual age were examined. Levene's test resulted in a significance level of .431, which was above the α of .05. ANOVA, Welch or Brown-Forsythe tests could not be used. The Kruskal Wallis test result for cleaning scores by age category was .031. Therefore, since this was < .05, the null hypothesis was rejected and it was concluded that there was a significant difference between ambulance cleaning scores and age of staff.

Pearson's correlation test (2-tailed) showed virtually no correlation ($r = .024$ at the .05 level) between cleaning scores and age of staff.

The cleaning scores of respondents by work experience were examined. The significance for Levene's test was .005, which was below the α of .05. It was therefore appropriate to use ANOVA. The significance level for ANOVA (with df = 34 and 117) was .000. Since this was < .05, it was concluded that there was a significant difference in the number of years worked, and cleaning scores.

Pearson's correlation test (2-tailed) showed that there was virtually no correlation ($r = .010$ at the .01 level) between cleaning scores and staff work experience.

4.3.9. Conclusion regarding ambulance cleaning

From the researcher's experience, damp conditions often exist in newly washed ambulances. Recently cleaned pieces of equipment are returned to their respective storage areas and are left to dry in this condition. However, there is often little air circulation to aid drying. It is not uncommon to find equipment still wet or damp from the previous days cleaning. Staff do not have the time to completely dry out equipment before replacing into the ambulance, due to outstanding calls. Judging from the responses to the above questions on ambulance cleaning, general ambulance cleaning methods are poor. This seems to be the case across the entire district. This is also evidenced by the widespread bacterial contamination of ambulances, particularly the coliform group of bacteria. Possible reasons for this are the claims of insufficient cleaning equipment, not enough time for comprehensive cleaning, and a possible lack of quality assurance mechanisms by management.

4.3.10. Personal protection

4.3.10.1. Occupational health risk

As elaborated upon in Chapter Two, 2.10, ambulance staff must be educated on safe working procedures and occupational risks to their health, particularly in respect of transmission of infection. In this study, a number of questions were asked regarding previous accidental exposure to patients' blood and body fluids, and steps taken by staff and management to prevent the occurrence of occupationally acquired infections. The first, in Table 36, describes the frequency of respondents' previous accidental exposure to body fluids.

Table 36: Have you ever been exposed to an accident involving the body fluids of a patient?

Responses		Frequency	Percent
Valid	Yes	67	54.9
	No	54	44.3
	Total	121	99.2
	Total unanswered	1	.8
Total		122	100.0

An alarmingly high exposure rate of 54.9% was reported by staff.

To ascertain what contamination incidents occurred amongst the participants in this study setting (see Chapter Two, 2.12), the participants were questioned further in order to ascertain the type of body fluid exposure. Table 37, summarizes their responses.

Table 37: Accidents/incidents involving exposure to patients' body fluids

Type of exposure	Frequency	Percentage
Blood/body fluids on skin	42	34.4
Blood/body fluids in eyes	5	4.6
Needlestick injury	18	14.7
Two or more types of body fluid exposure	4	3.2
Total	69	
Total unanswered	53	43.4
Grand total	122	100

As was expected, the greatest number of staff who reported body fluid exposure, were exposed to body fluids on skin (42 or 34.4%). Although contamination of intact skin poses little threat, contamination of broken skin is potentially harmful. This study did not investigate whether these exposures occurred on intact or broken skin.

Needlestick injury accounted for 18 (14.7%) of accidental exposures. Possible reasons for these incidences are that sharps containers are kept in the ambulance patient compartment and not taken to the scene of patient care. Needles are thus re-capped on scene, increasing the risk of such injuries. Another possible reason is that insufficient sharps containers are provided. To investigate this, staff members were asked whether sharps containers were provided. One staff member each from bases B, C, D and F indicated that there never was any sharps containers. Twenty (16.4%) said that there was not enough sharps containers sometimes, and 97 (79.5%) said that there was always enough sharps containers. Therefore, the incidences of needlestick injuries, in this study seem to be more as a result of the nature of emergency care work than the unavailability of sharps containers. Certainly, a well structured IC programme would help to minimize all body fluid contamination.

In order to ascertain whether the same staff members who reported needlestick injuries, also reported that there were not enough sharps containers, crosstabulations were run. Only one staff member who reported a needlestick injury also indicated that there never were enough sharps containers, again confirming the notion that the needlestick injuries were more likely due to the nature of the work.

Body fluid splash in the eyes accounted for 5 (4.6%) of exposures and 4 (3.2%) indicated exposure to two or more types of body fluid contamination. A large number 53 (43.4%) did not answer this question. A possible explanation for the lack of response is the somewhat personal nature of the question, although participant confidentiality was emphasized during the survey.

As stated in Chapter Two, 2.11, accidental exposure to body fluids is a concern, primarily because of the risk of contracting hepatitis B and C and HIV infections. According to Hiransuthikul, Hiransuthikul and Kanasuk (2007), the risk of HIV transmission to health care workers have been estimated to be approximately 0.3%, 0.09% and < 0.09% following percutaneous, mucous membrane, and non-intact skin exposures respectively.

Each exposure requires a different response, depending on the type of exposure, in order to prevent infection. The South Western Ambulance Service (2007) have guidelines to follow in the event of different types of exposure. Each of these are examined in relation to the reported actions of the respondents.

- Encourage bleeding from the wound by gently squeezing – as can be seen in Table 38, 61.1% of the staff who reported a needlestick injury did so.
- Wash the wound in soap and warm running water or with a disposable wipe if water is not available - in this study, of the staff that reported skin exposure, 42.8% of staff rinsed with water only and 50% of the staff

rinsed the affected area only once they arrived at hospital or base (Table 39). This practice increases their chance of contracting infection;

- Irrigate the eye or mouth splashes with plenty of water or saline – in this study 3 out 5 staff members did so (Table 40).
- Report incident to management – of the 67 staff members who reported exposure to body fluids, only 19 staff reported the incident to management.
- If the source of the injury is known, document details of the person involved.

No post-exposure guidelines could be located by the researcher in this study.

The tables below do not have a column total as each exposure could have more than one response.

Table 38: Needle-stick injury (n=18)

Procedure followed	Frequency	Percentage
Immediately squeezed and bled site	11	**61.1**
Immediately rinsed area with water	3	16.6
Immediately rinsed area with soap and water	4	22.2
Rinsed area on arrival at hospital or base	2	11.1
Reported incident to management	13	72.2
Was anti-viral medication administered?	11	61.1

Table 39: Skin exposure (n=42)

Procedure followed	Frequency	Percentage
Immediately rinsed area with water	18	42.8
Immediately rinsed area with soap and water	17	40.4
Rinsed area on arrival at hospital or base	21	50
Reported incident to management	4	9.5

Table 40: Eye exposure (n=5)

Procedure followed	Frequency	Percentage
Immediately rinsed area with water	3	60
Immediately rinsed area with soap and water	4	80
Reported incident to management	2	40
Was anti-viral medication administered?	4	80

Another vital component in infection prevention following a body fluid exposure, is early reporting of the incident to management. The Regulations for HBA (South Africa, 2001) state that staff should immediately report to the employer, any possible accidental exposure to a body fluid at the workplace, and that management should ensure that such an incident is investigated and recorded in accordance with the general administrative regulations. The USFA (2002) and the ASA (2004) also state that in the event of exposure, the incident needs to be reported. This is necessary in order for the affected staff to undergo a confidential medical evaluation, post-exposure prophylaxis and counselling.

The window period before systemic spread of HIV provides an opportunity for HIV post-exposure prophylaxis using antiretroviral drugs to block replication of HIV and prevent establishment of infection up to 72 hours following exposure (Hiransuthikul, Hiransuthikul and Kanasuk, 2007). Early post-exposure prophylaxis is therefore of importance. For this reason alone, management needs to be notified early.

In this study, only four of the staff exposed to body fluids on skin, reported the incident to management. None were given post-exposure prophylaxis by the employer. Of those staff members that had their eyes exposed to body fluid, only two of the eleven reported the incident to management. Four reported receiving post-exposure prophylaxis. By far, the most alarming are needlestick injuries, of which 13(72.2%) reported the incident to management. Of the 18 (14, 7%) staff that reported a needlestick injury, 11(61.1%) received post-exposure prophylaxis. Further details of the above exposures were not ascertained, as they were beyond the scope of this study. It must be acknowledged that these responses may have a degree of inaccuracy as the respondents had to recall incidents from memory.

As outlined in Chapter Two, 2.11., the Regulations for HBA (South Africa, 2001) as well as the ASA (2004) and USFA (2002) guidelines provide advice on appropriate control measures to avoid transmission of infection, including a suitable immunization policy and post exposure prophylaxis protocols.

Table 41: Against which of the following have you been immunized?

Vaccine	Immunization	Unsure	No immunization	Unanswered
Tetanus	11.5% (n=14)	4.9% (n=6)	63.1% (n=77)	20.5% (n=25)
Hepatitis A	9% (n=11)	5.7% (n=7)	64.8% (n=79)	20.5% (n=25)
Hepatitis B	52.5% (n=64)	4.9% (n=6)	22.1% (n=27)	20.5% (n=25)
Rubella	0.8% (n=1)	6.6% (n=8)	72.1% (n=88)	20.5% (n=25)
Poliomyelitis	2.5% (n=3)	6.6% (n=8)	69.7% (n=85)	21.3% (n=26)
Diphtheria	0	6.6% (n=8)	72.1% (n=88)	21.3% (n=26)
Tuberculosis	4.9% (n=6)	4.9% (n=6)	68.9% (n=84)	32,3% (n=26)

In this study, the respondents were asked about their immunization status. Table 41 summarizes their responses. It can be seen that staff immunization is poor, especially for Hepatitis A and B with only 11 (9%) and 64 (52.5%) being immunized respectively. This is of concern, given the nature of the EMS environment. The employer is accountable for staff medical surveillance and occupational health. This includes keeping of accurate health and immunization records for each member of staff. Staff members should be offered immunizations for diseases as required by specific incidents or local conditions (Chapter Two, 2.11). It is possible that some had received immunizations but were not aware of what they had been given or had forgotten, also accounting for the poor status indicated by the table.

4.3.10.2. Personal protective equipment

Ambulance staff members are particularly at risk of contracting an infectious disease, as they are often involved in situations involving excessive exposure to blood, trauma, childbirth and other situations like being spat on, scratched or bitten by patients (Chapter Two, 2.8.2.4). In the EMS environment, all body substances should be considered as potentially dangerous. Ensuring that staff are well protected is a means of breaking the chain of transmission of infectious agents.

The following questions were asked regarding hand hygiene. Table 42, show their responses.

Table 42: Questions regarding hand hygiene

Question	Yes, always	Sometimes	No, never	Unanswered	Total
Do you wear gloves when cleaning ambulances and equipment?	118(96.7%)	2 (1.6%)	0	2 (1.6%)	122 (100%)
Do you wash hands after removing gloves?	87 (71.3%)	33 (27%)	2 (1.6%)	0	122 (100%)
Do you wash hands at end of a shift, before leaving work?	75 (61.5%)	36 (29.5%)	9 (7.4%)	2 (1.6%)	122 (100%)

The majority of the staff 118 (96.7%) indicated that they wore gloves while cleaning ambulances, while 87 (71.3%) washed their hands after removing gloves worn during cleaning as well as during patient care. Washing hands after the use of gloves is critical, as micro-organisms can pass through latex gloves (Korniewicz et al., 1990). A possible reason for all staff not routinely washing their hands after glove removal is the very nature of the job. Staff, while working in the field, may not have access to washing facilities. Only 75 (61.5%) of staff washed their hands at the end of shift, before leaving for home. This is of concern as hand washing is the most effective overall IC measure (EHSB, 2007).

There is thus a risk of staff transmitting infectious diseases to their domestic environments. This is evidenced by the fact that in this study, a large percentage of sites regularly in contact with hands, were contaminated. For example, steering wheels were contaminated with seven species of bacteria. Rear door handles were contaminated with ten species of bacteria. Both these sites were contaminated with coliforms.

As detailed in Chapter Two, 2.8.2.4., personal protective equipment (PPE) serves as a control measure to reduce the risk of exposure. Protection is accomplished through the barrier technique, using PPE such as gloves, masks, protective eyewear and gowns to prevent contact with potentially infectious

materials, the selection of which is based on the anticipated risk of exposure to body fluid during the particular activity (USFA, 2002).

In this study, the respondents were asked to list all PPE that they used and when it would be used. Table 43 is a summary of their responses.

Table 43: List the PPE that you use and when it is used

Gloves		
When used	**Frequency**	**Percent**
When handling all patients	93	76.2
Protection from body fluids	6	4.9
Patients with skin infections	**1**	**.81**
No reason given	6	4.9
Did not list gloves	6	4.9
Unanswered	10	8.1
Total	**122**	**100**
Eye Protection		
Prevention of body fluid splashes	34	27.86
During IV therapy	**1**	**.81**
No reason given	2	1.6
Did not list eye protection	75	62.5
Unanswered	10	8.1
Total	**122**	**100**
Facemasks		
Protection from coughing or TB pts.	66	54.1
Protection from bacteria	1	.8
No reason given	4	3.3
Did not list facemasks	41	33.6
Unanswered	10	8.1
Total	**122**	**100**
Aprons		
Protection from body fluid	2	1.6
No reason given	2	1.6
Did not list aprons	108	88.5
Unanswered	10	8.1
Total	**122**	**100**

The majority of the staff - 102 (81.9%) listed gloves, and of these, 93 (76.2%) used them when handling all patients. Six staff members indicated that they used gloves for protection from body fluids and one staff member used it when handling patients with skin infections. It is unsure whether this staff member used gloves for this instance only. Six staff members did not list gloves at all. To investigate why gloves were not listed, crosstabulations were run for these staff members' responses against the question whether gloves were worn for cleaning. All six respondents indicated that they used them always. So it seems

that these respondents did use gloves, at least some of the time, but failed to indicate so in this particular question.

Facemasks, aprons and eyewear should be used during situations involving exposure to blood, trauma, childbirth, and other situations where gross contamination is anticipated or encountered. Judging from the relatively high body fluid exposure rates from Table 37, very few respondents indicated this in Table 43.

Although the respondents listed PPE and when it would be used, it needs to be readily available at all times in order to serve it's function. The respondents were asked whether there was sufficient equipment for them to protect themselves from becoming infected when working on ambulances. Table 44, summarizes their responses.

Table 44: Is there sufficient equipment available to protect yourself from being infected when working on ambulances?

Response	Frequency	Percent
No, never	50	41
Sometimes	52	42.6
Yes, always	19	15.6
Unanswered	1	.8
Total	122	100

Only 19 (15.6%) of the respondents agreed that there were always sufficient PPE, which is of great concern. Crosstabulations were performed to understand why these respondents indicated so. The respondents were mostly BLS qualified (n=14). As mentioned earlier on in the text, these staff members may have been newly recruited with limited work experience and knowledge on IC. They may be unaware of what constitutes proper PPE, and may have thus answered this question with an uninformed perspective.

Of greater importance, is to establish what PPE was not always available. This question was asked of the respondents and the results appear in Table 45.

Table 45: What PPE is not always available?

PPE	Not always available	Not listed	Not answered	Total
Gloves	.8% (1)	79.5% (97)	19.7% (24)	100% (122)
Facemasks	27% (33)	57.4% (70)	15.6% (19)	100% (122)
Eyewear	10.7% (13)	73% (89)	16.4% (20)	100% (122)

Only one respondent indicated that gloves were not always available, while 33(27%) indicated that facemasks were not always available and 13(10.7%) indicated that eyewear was not always available. In this table "not listed" refers to staff that answered this question, but only indicated either of the other two types of PPE. So, despite indicating that PPE was not always available, many did not enlarge upon what types were unavailable.

Not always having enough facemasks and eyewear available may be the reason that five of the 69 respondents who recorded body fluid exposure, reported eye contamination with body fluid (Table 37).

Although the risk of disease transmission from soiled clothing is minimal, the risk should not be ignored. It is important to be careful that blood or body fluids on uniform is not carried back to the staff member's domestic environment or to the general public via public transport (USFA, 2002). In this study district, staff generally come to work and go home dressed in the same uniform. From this author's own experience, this is standard practice for the rest of the province and even nationally. This practice was confirmed by asking whether they change into clean clothing at the end of a shift, before leaving work. Only six reported a change of clothing when going off shift. Seven indicated that this happened sometimes. Therefore, the protective practice of uniform changing is not being followed.

4.3.10.3. Protective practices scores

Questions 27, 36, 45, 30, 31, 32 and 33 were directed at personal protection against infectious diseases. These answers were each scored and converted to a percentage. An overall percentage score for protective practices was then calculated. The scores were then investigated for possible influences by, or relationships with other variables. This score is different to the cleaning score, as respondents were indicating what they personally did as opposed to what usually happened at the base.

As mentioned in Chapter Two, 2.11, age and years of work experience may have an influence on IC practices. In this study, there was a very weak positive relationship (.228 at the p = .05 level using Pearson's test) between age and protective practices scores. It was therefore to be expected that no significant difference between the age of staff and personal protection scores were found (Levene's test result was .029, ANOVA result was p = .313).

Similarly, a very weak positive correlation using Pearson's test (.253) at the p = .01 level was found between the number of years worked and the protective practices score. The Kruskal Wallis test indicated that there was no significant difference between these two variables.

The means scores for protective practices increased with the level of qualification (see Table 46).

Table 46: **Ambulance qualification and mean scores for protective practices**

Qualification	Mean scores	Standard deviation
Basic life support	26.8018	12.70721
Intermediate life support	36.0163	11.97728
Advanced life support	45.2381	16.98116
Total	30.9563	13.79024

There was a weak positive relationship (.382) between protection scores and ambulance qualification at the .01 level, using Spearman's rho test, indicating that the scores tended to increase as the qualification level increased. The difference in the scores according to qualification was found to be significantly different, using Welch (p = .002) and Brown-Forsythe (p = .003). ANOVA was not used as Levene's test result was .487. This difference in scores is expected, as the higher qualified staff generally had more work experience in IC. As part of training, ILS and ALS staff are required to undertake experiential learning at hospitals. Although IC does not form part of the curriculum, some IC practices could have been picked up informally in the hospital setting.

Finally, in order to see if there was a significant difference between the protection scores of the ambulance bases, the Welch test and the Brown-Forsythe tests were conducted. (Levene's had indicated that ANOVA could not be used). The results were p = .030 and p = .013 respectively, both indicating that the scores were in fact significantly different.

4.3.11. IC practice scores

The average practice score was 53.98% (Table 47). Although the practice score is also poor, it could be inaccurate as the staff reported what they would ideally do, and not what is actually practiced. There could be numerous reasons for this. As was reported by staff, there was not enough cleaning equipment, facilities and management quality assurance to ensure good cleaning practices. Furthermore, the unacceptably high contamination level of ambulances is further evidence of poor cleaning practices.

4.3.12. IC knowledge and practice

Table 47: Overall percentage score for knowledge as well as practice.

Overall % score for knowledge and practice questions	N	Mean
Knowledge score	122	31.57
Practice score	122	53.98
Valid N (listwise)	122	

There was no correlation between the knowledge and practice scores. This was checked by using Pearson's *r*. There were also no significant differences between the knowledge and practice scores using ANOVA, as well as Welch or Brown-Forsythe tests.

4.3.12.1. Knowledge and practice scores by base

The means of the knowledge and practice scores appeared to vary by base. All standard deviations for knowledge and practice scores were quite large, therefore the scores varied within the groups by a wide margin, except for ambulance base F which showed little variation.

Levene's test for homogeneity of variances between the knowledge scores of the bases, yielded a significance level of .305. Therefore, ANOVA could not be used. More robust tests were applied and indicated that there was no significant differences between the bases in terms of the respondents' knowledge scores (Welch test - .630; Brown-Forsythe test - .608).

Levene's test was performed for the staff practices scores and ambulance bases. The significance level was .016. ANOVA could not be used.

The standard error of the mean for staff knowledge scores by base were all similar.

There were no significant variances between the differences of the staff knowledge and practice scores by base.

4.3.12.2. Knowledge and practice scores by qualification

Tests for linear relationships between staff qualification and knowledge scores and staff qualification and practice scores showed significant linear relationships. Neither of the above had a deviation from linearity relationships, in addition to the above linear components.

R squared and Eta squared test scores were all close to 0, therefore the amount of variation in the scores that is explained by qualification, is small. Although the relationship is significant, there is little practical significance. The practice scores in IC are not surprising, since staff were possibly reporting on what should be practiced rather than what they personally did.

Spearmans's rho tests were performed to look for correlations between qualification and knowledge scores, and qualification and practice scores. The significance was .284 at the .01 level and .192 at the .05 level respectively. Both of these are close to 0, and so the first is a very weak positive correlation and there is virtually no correlation for the second set. It was concluded that to some extent the higher the qualification, the higher the knowledge score, which would be expected.

Multiple comparisons within groups for knowledge and qualification were performed. There was a significant difference between BLS and ALS knowledge scores (.029). There were large standard deviations for the ALS scores, which are not surprising, given the small number of them in the sample.

4.3.13. Staff general comments on infection control

The last question of the tool asked respondents if they had any general comments on IC, and 57 (46.7%) made comments. For ease of analysis, comments were coded and categorized. Table 48, summarizes their responses, ordered in decreasing frequency.

Table 48: General comments on IC

Comments	Frequency (%)
Management Intervention needed	14 (11%)
More education and training needed	16 (13.1%)
Policies and procedures needed	14 (11.5%)
More cleaning material and disinfectant needed	22 (18%)
Immunization programmes not completed	6 (4.9%)
Insufficient time to clean due to outstanding calls	5 (4.1%)
Poor quality of IC equipment	6 (4.9%)
Cleaning of ambulances needed to be out-sourced to IC cleaning teams	7 (5.7%)
Poor wash-bay facilities	2 (1.6%)
More PPE needed	2 (1.6%)

The general comments section at the end of the questionnaire yielded a poor response. This could possibly be due to this being the last question. Also a lot of staff may have felt that they had covered all their comments in earlier questions.

In order to gain more insight into the general comments, crosstabulations were performed between ambulance qualification, the responses to question 7, and those that indicated in the general comments, that more education and training in IC was needed.

Of the 16 staff that indicated the need for more education and training in their general comments, 7 BLS and ILS each also indicated in question 7 that they would like to learn more about IC.

4.3.14. Conclusion

Knowledge and practices of staff in IC was generally poor. This was substantiated by the unacceptably high levels of microbial contamination in ambulances. There were no significant differences between the bases. In certain cases, although the knowledge score was better, this did not equate to better practice. This in large part, seems to do with staff not having adequate resources, lack of IC policies and procedures, and good quality assurance from management.

A number of tests were performed to test the null hypothesis that the knowledge and practices of staff in ambulance IC will not differ at the different bases in the district. It was concluded that there were no significant differences.

4.4. The third objective was to establish whether there was a relationship between the levels of bacteria and fungi in the ambulances and the knowledge and practices of staff in ambulance infection control.

Defining relationships between the types and levels of bacteria and fungi, especially those species that are potentially pathogenic, and the knowledge and practices of staff is important. It adds value to the body of evidence gathered and either strengthens or weakens conclusions made in the discussion. Relationships were defined using the findings of Objective One and Two. This was investigated by searching for correlations between the micro-organism scores and the knowledge and practice scores, using Pearson's correlation tests.

As can be seen in Table 47, and already noted in Table 4, there was very little variation in the knowledge and practice scores for the respective bases. IC knowledge and practice was generally poor across the district. Apart from three micro-organisms (Micrococcus sp.,*Enterobacter cloacoe and Acinobacter* sp.) there was little difference between the bases regarding the types and levels of

contamination of ambulances. Similarly, there was no significant difference between the sample sites within the ambulances and the levels of bacteria and fungi, except for *Bacillus* sp. and *Pseudomonas* sp.

As discussed in Objective One, a scoring system was developed for all microbial species to obtain an overall microbial score for that sample. Similarly, as indicated Chapter Three, 3.5.5., responses to open-ended questions and those responses to “other” were coded and scored (see Annexure 10). Scores were analyzed as a whole, according to question, as well as per base.

Table 49: Descriptive statistics for mean scores by base

Base Code	Knowledge score (%)	Cleaning score (%)	Personal protection score (%)	Practice score (%)	Overall knowledge & practice score	Coliform score	Non-coliform score	Overall microbial score
Base A	48.06	56.63	31.50	44.07	**45.40**	1.00	1.82	**2.82**
Base B	45.59	53.88	36.21	45.04	**45.20**	0.83	2.00	**2.83**
Base C	48.62	62.50	32.05	47.28	**47.72**	0.79	1.29	**2.08**
Base D	52,75	57.99	26.11	42.05	**45.62**	0.83	2.00	**2.83**
Base E	47.69	47.44	23.85	35.84	**39.66**	1.42	1.58	**3.00**
Base F	51.83	57.64	23.89	40.76	**44.45**	0.75	1.71	**2.46**
Total	48.14	55.81	30.96	43.38	**44.97**	0.95	1.75	**2.70**

Correlations between scores were investigated using Pearson's correlation test. The result for the cleaning score and the coliform score was -.843 which was significant at the p = .05 level. Therefore, this inverse relationship can be interpreted as the lower the score for cleaning, the higher the coliform contamination.

The result for the overall knowledge and practices score and the coliform score was -.868, significant at the p = .05 level. This inverse correlation can be interpreted as the lower the score for IC knowledge and practices, the higher the coliform contamination.

Otherwise, no relationship between the scores for the levels of bacteria and fungi in the ambulances and the knowledge and practices of staff in ambulance IC were found. This may well be due to the method of scoring. However, it must be noted that the outcome for both Objectives One and Two were poor, and the consequence of poor cleaning is likely to be high levels of microbial contamination.

4.5. Conclusion for the overall results

In general, across the district, micro-organism contamination was unacceptably high, especially by the coliform group. This is understandably so, since the staff knowledge and practices in IC was generally poor. There were no significant differences between contamination levels at the different bases or the knowledge and practices of staff at the different bases.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

As mentioned in Chapter One, 1.6, senior management from the ambulance service under study had expressed concern regarding the lack of proper IC guidelines and the possible infection risk that this might pose for patients and staff. It was specifically in answer to their concern, that this study was conducted. The co-operation of management together with the 90% response rate of ambulance staff members to this survey indicates the willingness and commitment to improving IC practices of all stakeholders. These are strengths that should facilitate the utilization of the findings of the study.

The results of the microbiological survey indicated significant microbial contamination. Of particular concern, are the high contamination rates with the coliform group of bacteria. The knowledge and practices survey identified the lack of an ambulance IC programme in general, and the inadequacy of standard cleaning procedures, in eliminating micro-organisms from surfaces typically found in the ambulance. There were many shortfalls identified in the cleaning practices and procedures. These included a lack of designated cleaning equipment, insufficient time for effective cleaning, and the lack of suitable decontamination processes for medical equipment. Although saving lives is the top priority in EMS, hygienic protection of patients and ambulance staff are equally important. Limiting the ambulance staffs' role in the transmission of HCAI is possible.

The financial burden, due to the lack of an IC programme, which the EMS industry places on the health care system in South Africa, is unknown. However, given the financial constraints that are imposed upon the South African health care system, the effective prevention and control of infection within ambulances makes economic sense.

Ambulance staff members, by the very nature of their profession, have a higher risk of exposure to disease than most other health care professionals. This study has identified the need for a sound occupational health policy.

Research on IC has been largely hospital based. Little research has been conducted on the potential of the EMS as a medium for disease transmission. This study demonstrates clearly that such a potential exists.

In the health care setting, it appears that IC begins in the hospital casualty, passes through the medical and surgical units and ends in the hospital wards. The ambulance service seems to be regarded as a separate entity. Paradigms need to change. The EMS system should be considered as an extended arm of the hospital IC programme.

5.2. Recommendations

As stated in Chapter Two, 2.6., a generic IC programme consists of the following: identification of infectious disease processes and surveillance / epidemiologic investigation; preventing / controlling transmission of infectious agents; programme management / communication; education and research; and IC aspects of employee health.

5.2.1. IC programme implementation

No EMS specific IC programme exists in this study setting. This study has highlighted the need for one, and the information gathered (see Chapter Two, 2.11.) can be used in it's design.

In designing an IC programme, it is recommended that there should be better tailoring of information to staff needs, including initial and refresher training and education, participation in protocol development, training, and social support from co-workers and management. These interventions have been shown to be effective strategies for a safe working environment.

It is recommended that common policies be designed for the entire EMS community in South Africa. Many elements could be standardized nationally, for example, colour coding of cleaning equipment, identification of “high risk” patients, spillage and sharps policies, leaving other more parochial elements to be determined locally.

The Professional Board for Emergency Care Practitioners (PBECP), a division of the Health Professions Council of South Africa, regulates the scope of practice and publishes guidelines and protocols that EMS personnel are required to follow. It is recommended by this author, that the PBECP initiate the evolution of an ambulance specific IC policy. The PBECP should also be the regulating body that will ensure that all ambulance services in the country, comply with such a policy.

South Africa, being a developing country has it’s own unique problems with IC, mainly because of physical, environmental, and socio-economic factors. It differs markedly from that in the developed countries. Although information and advice from overseas experts is valuable, it is important that these differences are taken into account when formulating policies. There are advantages in involving local experts and EMS professionals in the development of such policies.

Once an IC programme has been designed, it is recommended that an IC committee made up of EMS staff and IC experts be set up. This group will oversee all IC activities, will devise and implement IC policies, and audit IC practices, including standards of cleanliness, regular updates, and immunization.

5.2.2. Ambulance cleaning procedures and practices

5.2.2.1. Ambulance cleaning at hospitals

It is essential that disinfection of spillages of blood and body fluids should be carried out promptly with a suitable chlorine releasing disinfectant. It is recommended that facilities be established at hospital casualty units, where

ambulance staff could clean body fluid spillages and medical equipment. All that is needed is cleaning equipment, example, buckets, mops and rags, and wash facilities with hot running water, detergent and a suitable chlorine based disinfectant.

5.2.2.2. General ambulance cleaning

It would seem that the general process of ambulance cleaning needs further consideration.

At the time of this study, there seemed to be no prescribed cleaning schedule at any one of the bases. Routine vehicle cleaning is a matter of great importance. Staff reported that they could only clean the ambulance at the end of shift of after a particularly dirty case. If a case resulted in body fluid spillage, the possibility of vehicle cleaning was sometimes dependant on the availability of equipment, detergent and disinfectant at the accident and emergency hospital units. Provision should be made for a cleaning schedule that has a systematic approach to cleaning and decontamination, including information on frequency and methods of cleaning. This information and instructions must be given to the staff and set out on notices displayed in the workplace.

The amount of time available for cleaning the ambulance before the next emergency call is another critical factor in the level of attention a vehicle would receive for cleaning. Because of the high case loads, most staff can only clean the ambulance at the end of a shift. This is normally a busy period in the day of an ambulance. It is recommended that shift change-over be staggered. A fifth shift could be implemented between 14h00 and 22h00 hours. This shift could respond to emergency calls during the normal shift change-over at 19h00 hours, giving the ambulance staff sufficient time for proper cleaning.

It is neither necessary, nor desirable to use disinfectants for routine cleaning. Detergent and hot water is adequate. Adequate supplies of detergent for general cleaning and chlorine releasing disinfectants for decontamination of blood spillages must be provided.

Cleaning equipment itself has been implicated in the spread of micro-organisms (Nigam and Cutter, 2003). In this study, 40.2% (n=49) of the staff used water only to clean the cleaning equipment. This is far from adequate. Sufficient mops, cloths, and buckets should be ,made available to allow the cleaning equipment itself to be cleaned and dried between use. In this study, 94 (77%) of the staff indicated that they shared cleaning equipment. Cleaning equipment should be dedicated solely to the cleaning of the ambulance. Each ambulance should have it's own set of colour-coded cleaning equipment. There is thus a sense of ownership. Staff will then be able to manage their own cleaning equipment as there is a sense of accountability.

Since the amount of time available for cleaning the ambulance before the next emergency call seems to be a critical factor in the level of attention a vehicle would receive for cleaning, alternate technologies should be considered for ambulance decontamination. As mentioned in Chapter Two, 2.8.2.2, the use of ultraviolet C-band (UV-C) lighting can be added to ambulance disinfection procedures. Another solution could be the use of vaporized hydrogen peroxide. This decontamination technology has been tested in hospital settings and has proved to be effective. Although both these technologies are relatively inexpensive overseas, this may not be the case in South Africa.

Certainly, hand washing remains a critical step in the transmission of HCAI. It is sometimes impractical to expect ambulance staff to maintain proper hand hygiene, as they often do not have access to soap and hot water. Waterless hand gels or an alcohol based hand rub should be immediately available so that they can disinfect their hands before donning gloves, after removing gloves, after

patient contact, and whenever in contact with the ambulance interior or medical equipment.

5.2.3. Ambulance design considerations

As new ambulances are designed and purchased, consideration must be given to the ability to decontaminate the patient compartment and equipment. Other design considerations should include ventilation, air filtration, and interior surfaces that are easy to clean.

Inter-hospital transfers undertaken by the ambulance service include severely debilitated patients, including ventilated neonates and patients being transferred to intensive care units or TB clinics. These patients and ambulance staff could be further compromised as a result of acquiring airborne infection from the ambulance environment. Unlike hospitals, where specialized units have negative pressure rooms for airborne infections like TB, ambulances do not have this option. It is recommended, however, that ambulances be fitted with high output extractor fans to minimize the threat of airborne infection.

Single-use disposable medical equipment is being frequently used as a means of controlling the transmission of infection. It is recommended that certain medical equipment, like oxygen humidifiers, be changed to single-use disposable ones.

5.2.4. Occupational health

It is recommended that precautions be taken by management for protection of staff against the health risks associated with exposure. In this study, the respondents indicated that there wasn't adequate medical surveillance (Chapter Four, 4.3.7.6)

Staff members should be offered immunizations for diseases as dictated by exposure to diseases endemic to the study district. In the event of an exposure, the staff member should receive a confidential medical evaluation, post-exposure

prophylaxis and counselling. There is therefore an urgent need for occupational health services to be made available to ambulance staff in the locality.

Although the risk of disease transmission from soiled clothing is minimal, the risk should not be ignored (USFA, 2002). Only 6 (4.9%) of staff reported a change of clothing when going off shift. It is recommended that staff change into a fresh set of clothes when going home. Uniform, if soiled, should be laundered at work. A spare set of uniform should be available at the base if needed.

5.3. Areas for future study

Evidence based design considerations (see Chapter Two, 2.8.2.2) for future ambulances, require research in numerous areas. These could possibly include:

patient compartment and equipment design to facilitate efficient cleaning, ventilation and air filtration

the use of alternate technologies, like ultraviolet light, and vaporized hydrogen peroxide for decontamination

evaluation of the incorporation of copper alloys into metal surfaces commonly touched by hands, example stretcher rails and oxygen flow control taps

Another possible research area is the establishment and evaluation of comprehensive IC surveillance systems that include EMS, so that HCAIs contracted in the prehospital phase can be identified.

As mentioned in Chapter One, 1.6., the researcher has been unable to locate any published research studies that have investigated ambulance contamination or the effectiveness of ambulance IC in South Africa. It is hoped that this baseline study will generate further research in the field of ambulance IC.

5.4. Closing statement

There is an urgent need for the development and implementation of evidence-based ambulance IC guidelines, both locally and for the country as a whole. The findings of this study clearly establish the need for such guidelines.

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Annexure 1

Department of Emergency Medical Care and Rescue
Corner of Ritson & St Thomas Rd
PO Box 1334
Durban
4000
12 July 2007

LETTER OF INFORMATION TO REQUEST STAFF MEMBERS TO PARTICIPATE IN STUDY BY COMPLETING THE QUESTIONNAIRE

Dear Participant,

I am conducting a research project in order to complete a Masters degree in Emergency Medical Care through the Department of Emergency Medical Care and Rescue, Durban University of Technology.

Title of research: *An assessment of ambulance infection control in an emergency medical service in the Ilembe District of KwaZulu-Natal.*

Name of research student:	S. Naguran
Contact Telephone No:	031 3735336
Name of supervisor:	Professor L. Grainger
Contact Telephone No:	031 373 5203
Name of Co – Supervisor:	Professor Y. Coovadia
Contact Telephone No:	031 360 3193

Purpose of the study: The purpose of the study is to assess ambulance infection control in an emergency medical service in the Ilembe District of KwaZulu-Natal by determining the prevalence of bacteria and fungi in ambulances and evaluating the knowledge and practices of staff in infection control.

All staff, who agree to participate in the study, and ambulances in the Ilembe District will be chosen for the study. You have been approached as you are a member of staff working on the ambulances in this district.

I am asking you to participate in the study because patient transport is the main function of any EMS system. To date, there has been no formal research conducted in South Africa regarding the spread of infection from patients to ambulance personnel and other patients during their transport. No clear policy

and procedures exist regarding infection control, particularly cleaning and decontamination of ambulances.

Procedure: The study consists of two parts. The first part requires you to complete a simple fifteen minute questionnaire and requires your honest response. It is concerned with your knowledge and practices of ambulance infection control. This will be completed whilst you are at the base, at shift change. *You are not required to state your name or address and all information will be treated in the strictest confidence.* There will be no way of identifying you from the returned questionnaires.

The second part of the study aims to find out if there are any potentially dangerous bacteria and fungi inside ambulances. Neither the ambulances nor the staff who work on them will be able to be identified from the results of the study.

Risks: There are no risks for participants or bases as strict confidentiality of the source of the information used in the study will be maintained. The results will be used for research purposes only.

Benefits: There are no financial benefits from this study. However, it is hoped that the results of the study will contribute to reducing healthcare associated infection for patients, ambulance staff and their families.

If you agree to participate, you will be required to complete the Durban University of Technology consent form. You may refuse to participate in the study or withdraw from the study at any stage without any adverse consequences.

You may request the results of the study when it is completed.

You may ask questions of an independent source if you wish (see supervisor contact details above). If you are not satisfied with any area of the study, please feel free to forward any concerns to my supervisor. Thank you once again for your interest and your decision to participate in this study.

Thank You

Sageshin Naguran
Research Student

Annexure 2

LETTER OF INFORMATION IN (isiZulu) TO REQUEST STAFF MEMBERS TO PARTICIPATE IN STUDY BY COMPLETING THE QUESTIONNAIRE

Dear Mbambiqhaza

Ngenza ucwaningo ukuze ngiphothule izifundo zami zeMasters degree emkhakheni wosizo oluphuthumayo lozokwelapha ngaphansi kwe Department of Emergency Medical Care and Rescue, eDurban University of Technology.

Isihloko socwaningo: Ukuhlolwa kokuvinjelwa kokuqhubezela phambili amagciwane kuma ambulance womnyango wezosizo oulphuthumayo lokwelapha kusifunda Ilembe KwaZulu-Natal

Igama lomcwaningi	:	S. Naguran
Inombolo yo cingo	:	031-3735336
Igama lombheki wocwaningo	:	Prof. L. Grainger
Inombolo yo cingo	:	031 3735203
Igama lomsizi wombheki cwaningo	:	Prof. Y. Coovadia

Inhloso yocwaningo: Lolucwaningo luhlose ukuhlola ulwazi nendlela yokusebenza yalabo abasebenza ezimotweni zosizo oluphuthumayo maqondana nokuhlanzwa, ukubulawa kwamagciwane nezinye izinxenye eziqondene nokuvinjelwa kokuqhubekela phambili kwamagciwane.

Onke ama ambulance nabasebenzi abanesifiso sokubamba iqhaza esifundeni Ilembe bayokhethwa ukuthi babambe iqhaza kulolucwaningo. Isifunda sakho sikhethwe ngoba sinama ambulance anele nabasebenzi abanele ukubamba iqhaza kulolucwaningo.

Ngikucela ukuthi ubambe iqhaza kulolucwaningo ngoba ukuthuthwa kweziguli kuwumgogodla wezosizo oluphuthumayo lozokwelapha. Kuze kube manje alukho ucwaningo oluke lwenziwa lapha eNingizimu Afrika maqondana nezinga lamagciwane, ukubhebhetheka kwamagciwane kusuka ezigulini kuya kubasebenzi bama ambulance, kanye nezinye iziguli ngesikhathi sokuthuthwa. Ayikho futhi imigomo nemilandela ekhona elandelwayo yokuvimbela ukuqhubekela phambili kwamagciwane ikakhulukazi mayelana nokuhlanzwa nokubulawa kwamagciwane kuma ambulance.

Indlelo yocwaningo: Ucwaningo lunemikhakha emibili. Umkhakha wokuqala udinga ukuthi uphendule ipheshana lemibuzo elizokuthatha imizuzu ethi ayibe yishumi nanhlanu futhi edinga ukuthi uliphendule ngokwethembeka. Kumayelana nolwazi nendlela esetshenziswayo ukuvikela amagciwane, kuzokwenziwa ngesikhathi usesemusebenzini sekeshitswa abasebenzi. Akudingekile ukuthi unikeze igama lakho noma idilesi lakho futhi lonke ulwazi olinukezayo luyogcinwa luyimfihlo. Uma sewubuyisa iphepha lemibuzo ngekekwaziwe ukuthi liqhamuka kuwe.

Umkhakha wesibili wocwaningo uhlose ukuthola ukuthi kungenzeka yini ukuthi kukhona izinhlobo ezithize zamagciwane ezingatholakala kuma ambulance. Imininingwane yabasebenzi nezinombolo zezimoto ngeke zishicilelwe emiphumelelweni yocwaningo..

Ubongozi: Abukho ubungozi ngalolucwaningo ngoba luzokwenziwa ngokuphendula imibuzo kuphela futhi aludingi lutho olunye oluzokwenziwa obambe iqhaza ngaphezu komsebenzi wakhe ojwayelekile. Imiphumelo izosetshenziswa kucwaningo kuphela.

Inzuzo: Akukho nzuzo enjengemali eyotholakala ngokubamba iqhaza kulolucwaningo. Kunethemba lokuthi imiphumela yocwaningo luyosiza ekuvimbeleni ukusabalala kwamagciwane kulabo abasebenza kuma ambulances, ezigulini kanje nasemindenini yabo.

Uma kuwukuthi uyavuma ubamba iqhaza, uzocelwa ukuthi ugcwalise iphesahana lesivumelwano sokuthi ubambe iqhaza elenziwe iDurban University of Technology. Unalo igunya lokungaba ukubamba iqhaza, noma ushiye phakhathi kungakapheli ucwaningo ngaphandle kokuhlukunyezwa.

Ungayicela imiphumela yocwaningo uma seluphothuluwe.

Ungabuza imibuzo komunye umuntu ongaphandle kocwaningo uma ifisa ukwazi kabanzi (Bheka imininingwane yombheki wocwaningo ngenhla).
Uma uganelisekile nganoma iyiphi inxenye yocwaningo, wamukelekele ukuthi ukhulumisane nombheki wocwaningo.

Ngithanda ukuthi ngiphinde ngibonge ngokubonisa kwakho isifiso sokuthi ubambe iqhaza kulolucwaningo.

Ngiyabonga

Sageshin Naguran

Annexure 3

INFORMED CONSENT FORM

Date : _____/_____/_____

Title of Research *An assessment of ambulance infection control in an emergency medical service in the Ilembe District of KwaZulu-Natal.*

Name of Supervisor	:	Prof. L. Grainger
Name of Co-Supervisor	:	Prof. Y. Coovadia
Name of Research Student	:	S. Naguran (031-3735336)
Name of Institution	:	Durban University of Technology
		Dept. of Emergency Medical Care & Rescue

The purpose of the study is to assess ambulance infection control in an emergency medical service in the Ilembe District of KwaZulu-Natal by determining the prevalence of bacteria and fungi in ambulances and evaluating the knowledge and practices of staff in infection control.

Please circle the appropriate answer

1. Have you read the participant information sheet? YES / NO
2. Have you had the opportunity to ask questions regarding this study? YES / NO
3. Have you received satisfactory answers to your questions? YES / NO
4. Have you had an opportunity to discuss this study? YES / NO
5. Have you received enough information about this study? YES / NO
6. Who have you spoken to?_____
7. Do you understand the implications of your involvement in this study? YES / NO
8. Do you understand that you are free to withdraw from this study?
    a) At any time? YES / NO
    b) Without having to give a reason for withdrawing and YES / NO
9. Do you agree to voluntarily participate in this study? YES / NO

PARTICIPANT NAME : _____ (in block letters)

Signature : _____

WITNESS NAME : _____(in block letters)

Signature : _____

RESEARCH STUDENT: Sageshin Naguran Signature : _____

If you have answered NO to any of the above questions, please do not hesitate to contact my supervisor/s who will be able to assist you.

Annexure 4

INFORMED CONSENT FORM (IN isiZULU)

Usuku : _____/_____/_____

Isihloko socwaningo: Ukuhlolwa kokuvinjelwa kokuqhubezela phambili amagciwane kuma ambulance womnyango wezosizo oulphuthumayo lokwelapha kusifunda Ilembe KwaZulu-Natal.

Igama lombheki wocwaningo	:	Prof. L. Grainger
Igama lomsizi wombheki cwaningo	:	Prof. Y. Coovadia
Igama lomcwaningi	:	S. Naguran (031-3735336)
Igama lesikhungo	:	Durban University of Technology Dept. of Emergency Medical Care & Rescue

Lolucwaningo luhlose ukuhlola ulwazi nendlela youkusebenza yalabo abasebenza ezimotweni zosizo oluphuthumayo futhi luhlose nokuthola izinhlobo zamagciwane atholakala kuma ambulance esifundeni Ilembe KwaZulu-Natal.

Yenza indingiliza empendulweni efanaleyo

1. Ulifundile yini ipheshana elinikeza imininingwane ngalolucwaningo na? Yebo / Cha
2. Ingabe ulitholile yini thuba lokubuza imibuzo mayelana nalolucwaningo na? Yebo / Cha
3. Wenelisekile yini ngezimpendulo zitholile emibuzweni obunayo ngalolucwaningo na? Yebo / Cha

Ulitholile yini ithuba lokukhuluma nomcwaningi maqondana nalolucwaningo na? Yebo / Cha

5. Ingabe imininingwane oyitholile mayelana nalolucwaningo ikwanelisile na? Yebo / Cha
6. Ubani okhulume naye:
7. Ingabe uqonda kahle ukuthi kusho ukuthini ukubamba iqhaza kulolucwaningo na? Yebo / Cha
8. Uyaqonda ukuthi ukhululekile ukuyeka ukubamba iqhaza kulolucwaningo na?

a) noma ngasiphi isikhathi Yebo / Cha

b) ngaphandle kokuthi unikeze izizathu zokuthi ushiye Yebo / Cha

9. Uyavuma ukuthi ubambe iqhaza kulololucwaningo na? Yebo /Cha

Igama lobambe iqhaza ocwaningweni: _____ Signature: _____

Ufakazi:_____Signature: _____

Igama Lomcwaningi:

Usuku: _____/_____/_____

Uma uphendule wathi cha kunoma yimuphi walemibuzo engenhla, Ngicela ungasabi ukuxumana nombheki cwaningo ungakusiza.

Corner of Ritson & St Thomas Rd
PO Box 1334
Durban, 4000

Annexure 5

LETTER OF INFORMATION: QUESTIONNAIRE PRE TEST GROUP

Corner of Ritson & St Thomas Rd
PO Box 1334
Durban
4000
Date: 23 July 2007

Name of research student : S. Naguran
Contact No : 031 3735336

Name of supervisor : Professor L. Grainger
Contact No. : 031 3735203

Name of Co – Supervisor : Professor Y. Coovadia

Name of institution : Durban University of Technology
Dept. of Emergency Medical Care & Rescue

Dear Participant,

I am conducting a research project in order to complete a Masters degree in Emergency Medical Care through the Department of Emergency Medical Care and Rescue, Durban University of Technology.

Title of research: *An assessment of ambulance infection control in an emergency medical service in the Ilembe District of KwaZulu-Natal.*

Purpose of the research: The purpose of the study is to assess ambulance infection control in an emergency medical service in the Ilembe District of KwaZulu-Natal by determining the prevalence of bacteria and fungi in ambulances and evaluating the knowledge and practices of staff in infection control by completing a fifteen minute questionnaire.

I am asking you to participate in the pre-testing of the questionnaire as you are representative of the population in the study. The structured questionnaire has been designed to collect data on the knowledge and practices of staff in ambulance infection control. Principles such as having a simple, uncluttered format, the sequencing of the questionnaire items, clear, non-leading and non-threatening wording of the items, and the length of the questionnaire have been considered.

The purpose of pre-testing is the assessment of the operational parameters of the attached questionnaire that will be utilised to gather the information required for the above mentioned research study. Please note that your identity and information will be treated with the utmost confidentiality.

Please feel free to ask any questions that you may have about your role in this evaluation, so that you clearly understand what is expected of you.

Please complete the questionnaire, taking note of the following:

- There is no collaboration with anyone else in answering any of the questions.
- Anything that was unclear or ambiguous to understand.
- Anything that made you feel reluctant to answer a question.
- The layout.
- The time taken to complete the questionnaire.

Please feel free to offer constructive criticisms, if any, once the questionnaire has been completed.

Thank You

Sageshin Naguran
Research Student

Annexure 6

LETTER TO THE DEPARTMENT OF HEALTH

Department of Health
Natalia
330 Langalibalele Street
PIETERMARITZBURG
3201

7 August 2007

Dear Sir / Madam

Re: Permission to conduct research

I wish to conduct a research project in order to complete a Masters degree in Emergency Medical Care through the Department of Emergency Medical Care and Rescue, Durban University of Technology.

Title of research: An assessment of ambulance infection control in an Emergency Medical Service in the Ilembe District of KwaZulu-Natal

Name of research student: Mr S. Naguran
Position: Lecturer
Contact No: 031 3735203
Name of supervisor: Professor Linda Grainger
Name of Co – Supervisor: Professor Y. Coovadia

The purpose of the study is to assess ambulance infection control in an emergency medical service in the Ilembe District of KwaZulu-Natal by determining the prevalence of bacteria and fungi in ambulances and evaluating the knowledge and practices of staff in infection control.

All ambulances and interested staff in the Emergency Medical Rescue Services of the Ilembe District, KwaZulu-Natal would be chosen for the study. This district has been chosen as it has an adequate sample size of ambulances and staff for a study of this magnitude. Furthermore, the District Manager Mr T. Larson has expressed willingness for the study to take place in his district.

To date, there has been no formal research conducted in South Africa regarding the incidence of infection, the spread of infection from patient to ambulance personnel, and the incidence of infection related to contaminated medical equipment. No clear protocol exists regarding infection control, particularly cleaning and decontamination of ambulances.

The study consists of three parts. The first part requires willing ambulance staff members to complete a simple fifteen minute questionnaire. The questionnaire covers aspects of infection control. The questionnaire will also be available in isiZulu.

The second part of the study aims to find out if there are any potentially dangerous bacteria and fungi inside ambulances. This will be achieved by swabbing different sites within the ambulances and analysing the samples at a laboratory. All costs will be borne by the researcher.

The third part of the study aims to define a relationship between infection control practice and the levels of microorganism contamination.

All data will be coded and handled confidentially to ensure anonymity. The name of the ambulance service, the bases in the district, the ambulances and staff will not be identified. Participation in the study is voluntary and participants will be required to complete a consent form.

Collection of data will take place at shift change. The researcher will be responsible for all data collection. The study will not impact on the normal operations of the service as data collection will occur at the bases before handover.

This study hopes to contribute to reducing healthcare associated infection for patients, ambulance staff and their families. A report containing the findings of the study will be forwarded to you. You are free to use the findings to implement policy. A copy of the research proposal is attached.

Do not hesitate to contact me if you require any information regarding my research study.

Thank You

Sageshin Naguran
Research Student

Annexure 7

LETTER TO THE IlEMBE DISTRICT MANAGER - EMRS

Ilembe District Manager
Emergency Medical Rescue Services
PO BOX 3432
Stanger, 4450
7 August 2007

Dear Sir

Re: Permission to conduct research

ATTENTION: Mr T. Larson

I am conducting a research project in order to complete a Masters degree in Emergency Medical Care through the Department of Emergency Medical Care and Rescue, Durban University of Technology.

Title of research: An assessment of ambulance infection control in an Emergency Medical Service in the Ilembe District of KwaZulu-Natal.

Name of research student: Mr S. Naguran
Position: Lecturer
Contact No: 031 3735203
Name of supervisor: Professor Linda Grainger
Name of Co – Supervisor: Professor Y. Coovadia

The purpose of the study is to assess ambulance infection control in an emergency medical service in the Ilembe District of KwaZulu-Natal by determining the prevalence of bacteria and fungi in ambulances and evaluating the knowledge and practices of staff in infection control.

All ambulances and interested staff in the Emergency Medical Rescue Services of the Ilembe District, KwaZulu-Natal would be chosen for the study. This district has been chosen as it has a convenient number of ambulances and staff for a study of this size. Furthermore, you have expressed willingness for the study to take place in your district pending approval from the Department of Health, KwaZulu-Natal.

To date, there has been no formal research conducted in South Africa regarding the incidence of infection, the spread of infection from patient to ambulance personnel, and the incidence of infection related to contaminated medical

equipment. No clear protocol exists regarding infection control, particularly cleaning and decontamination of ambulances.

The study consists of three parts. The first part requires willing ambulance staff members to complete a simple fifteen minute questionnaire**.** The questionnaire covers aspects of infection control. The questionnaire will also be available in isiZulu.

The second part of the study aims to find out if there are any potentially dangerous bacteria and fungi inside ambulances. This will be achieved by swabbing different sites within the ambulances and analysing the samples at a laboratory.

The third part of the study aims to define a relationship between infection control practice and the levels of microorganism contamination.

All data will be coded and handled confidentially to ensure anonymity. The name of the ambulance service, the bases in the district, the ambulances and staff will not be identified. Participation in the study is voluntary and participants will be required to complete a consent form.

Collection of data will take place at shift change. The researcher will be responsible for all data collection. The study will not impact on the normal operations of the service as data collection will occur at the bases before handover.

This study hopes to contribute to reducing healthcare associated infection for patients, ambulance staff and their families. A report containing the findings of the study will be forwarded to you. You are free to use the findings to implement policy. A copy of the research proposal is attached.

Do not hesitate to contact me if you require any information regarding my research study.

Thank You

Sageshin Naguran
Research Student

Annexure 8

QUESTIONNAIRE ON THE KNOWLEDGE AND PRACTICES OF STAFF ON AMBULANCE INFECTION CONTROL

Questionnaire Code

Thank you for agreeing to participate in my study. Remember that your answers will be kept confidential. Nobody else, apart from the researcher, will be able to identify who completed this questionnaire.

Instructions: Please tick the appropriate answer. Where indicated, please provide a short explanation.

1. Please give your age in years: ----------

2. How many years have you worked in an ambulance service? ----------

3. What is your ambulance qualification?

Basic Life Support	
Intermediate Life Support	
Advanced Life Support	
Other	

4. If you answered 'Other' to Question 3, please state what qualification/s you have:
……

5. Are there policies and procedures regarding infection control when working on ambulances in your service?

No	
Do not know	
Yes	

6. Do you feel that you are sufficiently informed about these policies and procedures regarding infection control?

Yes	
No	

7. If you answered 'No' to Question 6, would you be interested in learning more about control of infection in ambulances?,

Yes	
No	

8. If you answered 'Yes' to question 7, please list the aspects you would like to learn more about.

Instructions: Please tick the appropriate answer. Please note that there may be more than one answer. Where indicated, please provide a short explanation.

Please note that for the purposes of this research project, the word "clean" means to 'decontaminate' which refers to the procedures that are used to prevent infection from being spread through ambulances and their contents.
It has three levels comprising of cleaning, disinfection and/or sterilisation.

9. When are the ambulances at your base usually cleaned?

After every case	
Only when dirty	
End of shift	
End of shift or after dirty case	
Once a week	
Other	

10. If you answered "Other" to Question 9, please explain.

---

11. Why are they cleaned at these times.

---

12. How is the ambulance patient compartment usually cleaned?

With water	
With soap and water	
With soap and water followed by disinfectant like Cidex®	
With disinfectant like Cidex® only	
Other	

13. If you answered “Other” to Question 12 please explain.

---

14. How is the ambulance driver compartment usually cleaned?

With water	
With soap and water	
With soap and water followed by disinfectant like Cidex®	
With disinfectant like Cidex® only	
Other	

15. If you answered “Other” to Question 14, please explain.

---

16. When is equipment that has been used for patients usually cleaned?

After every case	
Only when dirty	
End of shift	
End of shift or after dirty case	
Once a week	
Other	

17. If you answered “Other” to Question 16, please explain.

---

18. How is this equipment usually cleaned?

With water	
With soap and water	
With soap and water followed by disinfectant like Cidex®	
With disinfectant like Cidex® only	
Other	

19. If you answered “Other” to Question 18, please explain.

---

20. How is cleaning equipment usually cleaned?

With water	
With soap and water	
With soap and water followed by disinfectant like Cidex®	
With disinfectant like Cidex® only	
Other	

21. If you answered “Other” to Question 20, please explain.

---

22. What is a detergent used for?

---

23. What is a disinfectant used for?

---

24. Have you ever been exposed to an accident involving the body fluids of a patient (for example a needle stick injury)?

Yes	
No	

25. For which of the following accidents/incidents involving the body fluids of a patient have you been exposed to?

Blood/body fluids on skin	
Blood/body fluids in mouth	
Blood/body fluids in eyes	
Needle stick injury	
Bitten by patient	
Other	

26. If you answered “Other” to Question 25, please explain

---

27. For each accident/incident described above, please describe the procedure that you followed to prevent yourself from getting an infection.

Immediately rinsed exposed area with water	
Immediately rinsed exposed area with soap and water	
Rinsed exposed area on arrival at hospital or base	
Immediately squeezed and bled needle stick site	
Reported the incident to management	
Was given anti- viral medication	
Other	

28. If you answered “Other” to Question 27, please explain.

---

29. Is cleaning equipment shared between ambulances?

No, never	
Sometimes	
Yes, often	

30. Do you wear gloves when cleaning ambulances and equipment?

No, never	
Sometimes	
Yes, always	

31. Do you wash your hands after removing gloves?

No, never	
Sometimes	
Yes, always	

32. Do you wash your hands at the end of a shift, before leaving work?

No, never	
Sometimes	
Yes, always	

33. Do you change into clean clothing at the end of a shift, before leaving work?

No, never	
Sometimes	
Yes, always	

34. Can germs pass through latex gloves?

No	
Yes	

35. Do you think that it is possible for you to become infected when you are working on the ambulances?

No	
Unsure	
Yes	

36. Please list the equipment that you use to protect yourself from being infected when handling patients (for example gloves). Next to each type of equipment, please explain when you use it (i.e. what makes you decide to use it).

Type of protective equipment	When used

37. Is it possible for germs to live in dried blood for up to six months?

Yes	
Unsure	
No	

38. Is there a chance of being infected when a needle that has been used on a patient penetrates your skin?

Yes	
Unsure	
No	

39. Is there sufficient equipment for you to protect yourself from becoming infected when working on the ambulances?

No, never	
Sometimes	
Yes. Always	

40. If you have answered 'No' to Question 39, please list what is not always available:

---

41. Are there sufficient sharps containers on ambulances?

No, never	
Sometimes	
Yes. Always	

42. Do you have sufficient time to clean your ambulance?

No, never	
Sometimes	
Yes. Always	

43. Is cleaning equipment readily available?

No, never	
Sometimes	
Yes. Always	

44. Is cleaning and disinfection of ambulances regularly checked by management?

No, never	
Sometimes	
Yes. Always	

45. Against which of the following have you been immunised?

Type of infection	Yes	Unsure	No	If 'Yes', give the date of last immunisation
Tetanus				
Hepatitis A				
Hepatitis B				
Rubella				
Poliomyelitis				
Diphtheria				
Tuberculosis				
Chickenpox				

46. Apart from what you have already stated in the above responses, are there any comments or problems regarding infection control that you would like to mention?

Annexure 9

QUESTIONNAIRE ON THE KNOWLEDGE AND PRACTICES OF STAFF ON AMBULANCE INFECTION CONTROL – IN ISIZULU

Questionnaire Code

Ngiyabonga ukuvuma ukubamba iqhaza kulolucwaningo. Khumbula ukuthi impendulo yakho izoba imfihlo, akekho omunye umuntu ongayibona ngaphandle komcwaningi.

Imiyalelo: Thikha impendulo obona ifanelekile, lakufanele khona, uchaze kafushane uma kunesidingo.

1. Iminyaka yakho _____

2. Sewusebenze isikhathi esingakanani ezimotweni zosizo oluphuthumayo lozokwelapha?_____

3. Khombisa izinga ofunde wafinyelela kulo kwezama ambulance?

Basic Life Support	
Intermediate Life Support	
Advanced Life support	
Okunye	

4. Uma impendulo ithi “okunye” kumbuzo 3, sicela ubhale iziga lakho.
_____

5. Ikhona yini imigomo nemiyalela ngokuvimbela ukuqhubeka phambili kwamagciwane lapho usebenza khona?

Qha	
Mhlambe	
Yebo	

6. Ngabe uqeqesheke ngokwanele ngezindlela zokuvimbela ukuqhubezela phambili amagciwane?

Qha	
Yebo	

7. Uma impendulo yakho ithi Qha kumbuzo 6, ungathanda yini ukufunda kabanzi ngokuvinjelwa kokuqhubezela phambili amagciwane kuma ambulance?

Yebo	
Qha	

8. Uma impendulo yakho ithi YEBO kumbuzo 7, nikeza uhla lemikhakha ongafiswa ukuthi ifakwe kulezizifundo.

Chaza kafushane kulenimbuzo elandelayo mayelana nezindlela zokuvikela ukuqhubekela phambili kwamagciwane ema ambulensini.

Uyaziswa ukuthi igama elithi "decontaminate" limele indlela esetshenziswayo ukuvikela ukusabalala kwamaciwane kuma ambulance. Lihlukene izigaba ezintathu "cleaning, disinfection no sterilisation".

9. Ahlanzwa nini ama ambulensi esikhungweni sawo?

Emva kosizo oliphuthumayo noma ekuhlengeni	
Uma ingcolile	
Ekupheleni komsebenzi	
Kanye ngeviki	
okunye	

10. Uma impendulo yakho kumbuzo 9 ithi " okunye" sicela ucaze.

---

11. Yini indaba ahlanzwe ngalesisikhathi?

---

12. Ulihlanza kanjani igumbi lesiguli kwi ambulensi?

Ngamanzi	
Ngamanzi nensipho	
Ngamanzi, yinsipho uladelise ngesibulala maciwane njenge Cidex®	
Ngesibulala maciwane njenge Cidex® kuphela	
Okunye	

13. Uma impendulo yakho kumbuzo 12 ithi " okunye" sicela ucaze.

---

14. Ulihlanza kanjani igumbi lapho kuhlala khona umshayeli we ambulance?

Ngamanzi	
Ngamanzi nensipho	
Ngamanzi, yinsipho uladelise ngesibulala maciwane njenge Cidex®	
Ngesibulala maciwane njenge Cidex® kuphela	
Okunye	

15. Uma impendulo yakho kumbuzo 14 ithi " okunye" sicela ucaze.

---

16. Ihlanzwa nini imishini esetshenziswa ezigulini?

Emva kosizo oliphuthumayo noma ekuhlengeni	
Uma ingcolile	
Ekupheleni komsebenzi	
Kanye ngeviki	
okunye	

17. Uma impendulo yakho kumbuzo 16 ithi " okunye" sicela ucaze.

---

18. Uyihlanza kanjani imishini esetshenziswa ezigulini?

Ngamanzi	
Ngamanzi nensipho	
Ngamanzi, yinsipho uladelise ngesibulala maciwane njenge Cidex®	
Ngesibulala maciwane njenge Cidex® kuphela	
Okunye	

19. Uma impendulo yakho kumbuzo 18 ithi " okunye" sicela ucaze.

---

20. Uyihlanza kanjani imishini yokuhlanza

Ngamanzi	
Ngamanzi nensipho	
Ngamanzi, yinsipho uladelise ngesibulala maciwane njenge Cidex®	
Ngesibulala maciwane njenge Cidex® kuphela	
Okunye	

21. Uma impendulo yakho kumbuzo 20 ithi " okunye" sicela ucaze.

---

22. Isetshenziselwani i-detergent?

---

23. Isetshenziselwani i-disinfectant?

---

24. Wake wahlangabezana nengozi eqondene noketshezi olohambisana negazi lesiguli (Njengo kuhlatshwa inaliti).

Qha	
Yebo	

25. Kuziphi kulezizingozi ezazihambiselana noketshezi lwegazi lesigili owake wahlangabezana nayo?

Uketshezi lwegazi olusuka esikhumba	
Uketshezi lwegazi olusuka emlonyeni	
Uketshezi lwegazi olusuka emehlweni	
Ukuhlatshwa inaliti	
Ukulunywa isiguli	
okunye	

26. Uma impendulo yakho kumbuzo 25 ithi " okunye" sicela ucaze.

---

27. Kwizingozi ezibaliwe ngaphezulu, sicela usicazele imigomo nemiyalelo owayilandela ukuvikela ukungenwa amaciwane.

Wahlamba kuleyondawo ngamanzi ngokushesha	
Wahlamba kuleyondawo ngamanzi nensipho ngokushesha	
Wahlamba kuleyondawo ngesikhathi ufika esibhehlela noma esiteshini	
Wacindezela kuleyondawo eyahlatshwa inaliti	
Walubika udaba kwabakuphethe	
Wanikwa imithi yokuvikela amaciwane	
okunye	

28. Uma impendulo yakho kumbuzo 27 ithi " okunye" sicela ucaze.

---

29. Ngabe imishini yokuhlanza iyabolekiswa kwamanye ama ambulensi?

Nhlobo	
Kwesinye isikhathi	
Yebo, njalo	

30. Uyawaqhoka yini amagloves uma uhlanza I ambulensi?

Nhlobo	
Kwesinye isikhathi	
Yebo, njalo	

31. Ngabe izandla ziyagezwa emva kokukhumula amagloves?

Nhlobo	
Kwesinye isikhathi	
Yebo, njalo	

32. Ngabe izandla ziyagezwa uma sekuyisikhathi sokushayisa ngaphambi kokugoduka?

Nhlobo	
Kwesinye isikhathi	
Yebo, njalo	

33. Uma usogoduka emva kokushayisa emsebenzini, ngabe uyashintsha ugqoke izingubo zakho ezihlukile kulezi zomsebenzi?

Nhlobo	
Kwesinye isikhathi	
Yebo, njalo	

34. Ngabe ezinye izinhlobo zamagciwane ziyakwazi ukungena kuma latex gloves?

Qha	
Yebo	

35. Akhona amathuba akothi uthole amagciwane lawusebenza khona ema ambulensini?

Qha	
Mhlambe	
Yebo	

36. Ngicela ubhale izivikelo ozisebenzisayo ukuvikela ukungenwa amagciwane uma uphethe izuguli(njenge, amagloves). Eduze kwesivikelo, chaza ukuthi usisebensisa nini(yini ekutshela ukuthi sisebenzise).

Izinhlobo zezivikelo	Zisetshenziswa kuphi

37. Ngabe akhona yini amathuba okuthi amagciwane ahlale egazi elomile izinyanga iziyisithupha?

Yebo	
Mhlambe	
Qha	

38. Akhona amathuba okuhlaselwa amagciwane uma uhlatshwe inaliti esike yasetsenziswa kwesinye isiguli?

Yebo	
Mhlambe	
Qha	

39. Ngabe zanele yini izivikelo zakho ozisebenzisayo emsebenzini ukuvikela amagciwane?

Nhlobo	
Ngesiye isikhathi	
Yebo, njalo	

40. Uma impendulo yomubuzo 31 kuwu “nhlobo”, bhala izinto ezingatholakali njalo:

_____
_____
_____

41. Akhona ngokwanele yini ama sharps containers?

Nhlobo	
Ngesiye isikhathi	
Yebo, njalo	

42. Niyaba nesikhathi esanele sokuhlanza I ambulensi?

Nhlobo	
Ngesiye isikhathi	
Yebo, njalo	

43. Itholaka ngokusheshe yini imishini yohlanza ama amabulensi?

Nhlobo	
Ngesiye isikhathi	
Yebo, njalo	

44. Abaphathi besemsebensini bayakunaka yini ukuhlanzwa kwama abulensi?

Nhlobo	
Ngesiye isikhathi	
Yebo, njalo	

45. Ikuphi kuloluhla olungezansi osuke wagonyelwa khona?

Izinhlobo zamaciwane	Yebo	Hlawubhe	cha	Uma “Yebo” sinike izinsuku owagonya ngazo
Tetanus				
Hepatitis A				
Hepatitis B				
Rubella				
Poliomyelitis				
Diphtheria				
Tuberculosis				
Chickenpox				

46.. Ngaphandle kwalokho osukushilo ezimpendulweni zemibuzo engaphezulu, kukhona yini ofisa ukukusho noma izinkinga mayelana nokuvikelwa kokuqhubekela phambili kwamagciwane ofisa ukukusho?

_____
_____
_____

NGIYABONGA NGOSIZO LWAKHO
S.NAGURAN

Annexure 10

QUESTIONNAIRE SCORE SHEET

Preventing / Controlling Transmission of Infectious Agents Through Ambulance Decontamination Practice – Scoring Sheet

Grading	Point Distribution	Participant Score
Excellent	30-36	
Good	23-29	
Satisfactory	19-24	
Poor	0-18	

Risk Perception, Knowledge and Practice in Preventing / Controlling Transmission of Infectious Agents – Scoring Sheet

Grading	Point Distribution	Participant Score
Excellent	20-26	
Good	16-19	
Satisfactory	13-15	
Poor	0-12	

1. Please give your age in years: ----------

2. How many years have you worked in an ambulance service? ----------

3. What is your level of ambulance education?

Basic Life Support	
Intermediate Life Support	
Advanced Life Support	
Other	

4. If you answered 'Other' to Question 3, please state what qualification/s you have:

……

5. Are there policies and procedures regarding infection control when working on ambulances in your service?

No	0
Do not know	1
Yes	2

6. Do you feel that you are sufficiently informed about these policies and procedures regarding infection control?

Yes	1
No	0

7. If you answered 'No' to Question 6, would you be interested in learning more about control of infection in ambulances?,

Yes	1
No	0

8. If you answered 'Yes' to question 7, please list the aspects you would like to learn more about. (3)

Please provide a short explanation for the following questions about how the spread of infection through ambulances are prevented (i.e. Questions 9 - 17).

9. When are the ambulances at your base usually decontaminated?
After every patient (3)
Shift change (2)
Once a week (1)
When visibly soiled (1)

10. Why are they decontaminated at these times (i.e. what happens at these times that makes you do it then)?

11. How do you usually decontaminate your ambulance patient compartment?
Body fluid – soap and water followed by disinfectant (1)
All other surfaces – soap and water (1)
Surfaces left to dry (1)

12. How do you usually decontaminate your ambulance driver compartment?
Body fluid – soap and water followed by disinfectant.(1)
Otherwise soap and water.(1)
All levers, handles and the steering wheel regularly washed with soap and water or mild disinfectant. (1)

13. When do you decontaminate equipment that has been used for patients?
After every patient (2)
When it is visibly soiled (1)

14. How do you decontaminate this equipment?
If soiled – soap and water followed by disinfectant (1)
Otherwise – soap and water (1)

15. How is cleaning equipment decontaminated?
With bleach solution (2)
Alcohol solution (2)
Other appropriate disinfectant (2)

16. What is a detergent used for?
A detergent like soap is used to make cleaning or removal of organic matter easier (2)

17. What is a disinfectant used for?
A disinfectant reduces the number of viable microorganisms (2)

18. Is cleaning equipment shared between ambulances?

No, never	2
Sometimes	1
Yes, often	0

19. Do you wear gloves when cleaning ambulances and equipment?

No, never	0
Sometimes	1
Yes, always	2

20. Do you wash your hands after removing gloves?

No, never	0
Sometimes	1
Yes, always	2

21. Do you wash your hands at the end of a shift, before leaving work?

No, never	0
Sometimes	1
Yes, always	2

22. Do you change into clean clothing at the end of a shift, before leaving work?

No, never	0
Sometimes	1
Yes, always	2

23. Can germs pass through latex gloves?

No	1
Yes	0

24. Do you think that it is possible for you to become infected when you are working on the ambulances?

No	0
Unsure	0
Yes	1

25. Please list the equipment that you use to protect yourself from being infected when handling patients (for example gloves). Next to each type of equipment, please explain when you use it (i.e. what makes you decide to use it).
Gloves (1) – reason (1)
Eyewear (1) – reason (1)
Facemask (1) – reason (1)
Gown (1) – reason (1)

26. Have you ever been exposed to an accident involving the body fluids of a patient (for example a needle stick injury)?

Yes	1
No	0

27. If you answered 'Yes' to Question 26, please describe what happened. Please give a description for each accident.

28. For each accident described above, please describe the procedure that you followed to prevent yourself from getting an infection.

29. Is it possible for germs to live in dried blood for up to six months?

Yes	1
Unsure	0
No	0

30. Is there a chance of being infected when a needle that has been used on a patient penetrates your skin?

Yes	1
Unsure	0
No	0

31. Is there sufficient equipment for you to protect yourself from becoming infected when working on the ambulances?

No, never	0
Sometimes	1
Yes. Always	2

32. If you have answered 'No' to Question 31, please list what is not always available:

33. Are there sufficient sharps containers?

No, never	0
Sometimes	1
Yes. Always	2

34. Do you have sufficient time to clean your ambulance?

No, never	0
Sometimes	1
Yes. Always	2

35. Is cleaning equipment readily available?

No, never	0
Sometimes	1
Yes. Always	2

36. Is cleaning and disinfection of ambulances regularly checked by management?

No, never	0
Sometimes	1
Yes. Always	2

37. Against which of the following have you been immunised?

Type of infection	Yes	Unsure	No	If 'Yes', give the date of last immunisation
Tetanus	1			
Hepatitis A	1			
Hepatitis B	1			
Rubella	1			
Poliomyelitis	1			
Diphtheria	1			
Tuberculosis	1			
Chickenpox	1			

38. Apart from what you have already stated in the above responses, are there any comments or problems regarding infection control that you would like to mention?

Annexure 11

INFORMATION AND DATA CODING CHECKLIST PER AMBULANCE

Site Code	Site
1	Seat belt
2	Stretcher handles
3	Oxygen flow-control taps
4	Inside surface of suction apparatus reservoir
5	Inside surface of oxygen humidifiers
6	Stethoscope diaphragm
7	Sphygmomanometer cuff internal surface
8	Rear door handle
9	Steering wheel
10	Head end of stretcher mattress
11	Settle plate (front end of patient compartment)
12	Settle plate (rear end of patient compartment)

Swab Label	Base	Base Code	Reg. No.	Ambulance Code	Site	Site Code	Date	Time

Actual version will have a row for each of the168 samples.

1. When was the ambulance last cleaned?

   ---

2. How was it cleaned?
   ---

3. How many patients were transported during the preceding shift?

   ---

4. What health problems did they have?
