A Review of Healthcare-Acquired Infection Surveillance Systems

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Abstract

Introduction:
Healthcare-acquired infections (HAIs) are a common adverse health event affecting hospitalised patients in both developing and developed countries. They are associated with substantial health and economic burden on patients and healthcare systems. Therefore, it is critical that programmes are in place to reduce the burden of infection in already vulnerable hospitalised patients. Surveillance systems for HAIs are vital for effective prevention and control of HAIs and are a cost effective approach to reducing disease. The importance of surveillance systems for HAI control has been accepted globally and many countries have established national surveillance systems with the aim to prevent HAIs.

This project commenced after consultation with contacts from the Southern District Health Board (SDHB) requesting an investigation to identify the approach to HAI surveillance in SDHB hospitals. Prior to study, the HAI surveillance system in Dunedin Hospital involved reporting to a variety of bodies. Additionally, minimal information was known about the overarching collation of internal reporting.

Aims
The study presented in this thesis aimed to review hospital surveillance systems for HAIs in New Zealand and internationally. There are three key objectives to this study: 1. To identify and review the fundamentals of HAI surveillance and to establish international best practice. 2. To conduct an in depth case study of HAI surveillance in SDHB hospitals. 3. To identify the HAI surveillance performed in other New Zealand DHB hospitals.

Methods:
International best practice for HAI surveillance was established by a literature review. Key stakeholder interviews were performed with clinical and managerial staff from SDHB hospitals to gain an understanding of the surveillance performed in SDHB hospitals. A self-administered questionnaire was developed to review the HAI surveillance performed in other New Zealand hospitals.
Results:
The literature review found that many developed counties including Australia, England, Scotland, The Netherlands, Germany, and France have adapted the Center for Disease Control and Prevention’s National Nosocomial Infection Surveillance, which has now developed into the National Healthcare Safety Network for the surveillance of HAIs. The national approach allows for benchmarking and uses standardised HAI definitions, data collection and reporting methods.

The study presented in this thesis found that the infection prevention and control team in Dunedin Hospital and the infection control team in Southland Hospital implement surveillance on blood stream infections, multidrug resistant organisms and Clostridium difficile infections. The maternity wards in both hospitals perform their own in-patient and post discharge surveillance for caesarean wound infections. Within Dunedin hospital the neonatal and intensive care units implement in-house surveillance on line-associated infections and central line-associated bacteraemia respectively.

The national HAI surveillance questionnaire found that the majority of the main HAIs are under surveillance in surveyed DHB hospitals with the exception of catheter associated urinary tract infections and ventilator associated pneumonia. The methods used for surveillance and the reporting of surveillance information vary for each DHB hospital and each type of infection. Most hospitals surveyed perceived themselves as “good” or “very good” for the timeliness of collecting and reporting, validity of data collection, accuracy and completeness of numerator and denominator data, application of HAI surveillance data and analyses of HAI surveillance data.

Discussion and Conclusions:
The approaches to HAI surveillance in New Zealand DHB hospitals vary according to infections monitored, protocols used, analysis performed and dissemination of data. The New Zealand Health Quality & Safety Commission has provided an essential start to a collaborative approach to SSI surveillance. A willingness of hospital staff to engage in HAI surveillance programmes is fundamental for success. The collection of national HAI surveillance data is important as it would allow for the identification of national trends and benchmarking. This would be achieved as a by-product of locally established cohesive surveillance systems.
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List of Abbreviations

**ACSQHC**: Australian Commission on Safety and Quality in Health Care

**BAL**: Bronchoalveolar lavage- A diagnostic procedure in which a bronchoscope is passed through mouth or nose

**BSI**: Bloodstream infection

**CDC**: Centres for Disease Control and Prevention

**CDI**: *Clostridium difficile* infection

**CLAB**: Central line-associated bacteraemia

**cUTI**: Catheter associated urinary tract infection

**ESBL**: Extended spectrum beta lactamase- Enzyme produced by some bacteria that provide resistance to beta-lactam antibiotics.

**FTE**: Full Time Equivalents

**GNI**: Gross national income

**HAI**: Healthcare acquired infection

**HAIGG**: Healthcare Associated Infections Governance Group

**HQSC**: Health Quality and Safety Commission New Zealand

**HRN**: High risk nursery

**HRT**: Health Round Table

**IC**: Infection control

**ICP**: Infection control personnel/professional

**ICU**: Intensive care unit

**IPC**: Infection prevention and control

**MDROs**: Multi drug resistant organisms

**NHSN**: National Healthcare Safety Network - NNIS reformed
NICU: Neonatal Intensive care unit

NNIS: National Nosocomial Infection Surveillance - developed by the CDC in America

QIC: Quality Improvement Committee

QM: Queen Mary- Maternity ward in Dunedin hospital

SDHB: Southern District Health Board

SENIC: Study on the Efficacy of Nosocomial Infection Control

SIC-IR: Surgical intensive care-infection registry

SSI: Surgical site infections

UTI: Urinary tract infection

VAP: Ventilator associated pneumonia

WHO: World Health Organization
1 Introduction

Healthcare acquired infections (HAIs) are associated with increased morbidity and mortality, prolonged hospital stays and generate substantial economic healthcare costs (Burke, 2003). HAIs are of major public health importance worldwide. They can occur in all healthcare settings with an estimated 3.5-12% of hospitalised patients affected in developed countries (World Health Organisation (WHO) 2011). In New Zealand it is estimated that approximately 10% of patients admitted to hospital acquire an infection as a result of their hospital stay, costing New Zealand’s healthcare system an estimated $137 million per year (Burns et al., 2010).

Surveillance systems are a way of identifying HAIs, tracking trends, providing quality outcome indicators, and identifying actions to reduce the burden of HAI (Kilpatrick and Reilly, 2002). Successful hospital infection control programmes include surveillance to detect common source outbreaks, to meet national standards and to generate data that identifies problem areas in order to help clinicians and managers to set new priorities and make improvements in infection control practices. Surveillance followed by improvements has been shown to produce considerable reductions on rates of HAIs (Gaynes et al., 2001).

Prior to this study, HAI surveillance at Dunedin Hospital involved reporting to a variety of bodies, with no overall control and minimal internal reporting. This project commenced after consultation with contacts from the Southern District Health Board (SDHB) requesting an investigation to describe the approach to HAI surveillance in SDHB hospitals. It was also established that a series of recommendations based on international best practice would be beneficial for SDHB hospitals and would help improve their system. Results obtained from this study were also used to develop a report to SDHB detailing their approach to HAI surveillance in Dunedin and Southland hospitals.
1.1 Aim and Objectives

The study presented in this thesis aimed to review hospital surveillance systems for HAIs in New Zealand and internationally. There are three key objectives to this study:

1. To identify and review the fundamentals of HAI surveillance and to establish international best practice.
2. To conduct an in-depth case study of HAI surveillance in SDHB hospitals.
3. To identify the HAIs surveillance performed in other New Zealand DHB hospitals.

1.2 Thesis Summary

The thesis presented is divided into seven chapters: The background section highlights the significance of HAIs and surveillance; it includes definitions, the major types of HAIs, and sets the context of the study. The literature review is divided into three focus areas, targeting three main objectives: 1. To identify the fundamentals of HAI surveillance; 2. To identify and review HAI surveillance systems used in developed countries and establish best practice and 3. To review surveillance criteria and frameworks for the evaluation of HAI surveillance, and to adopt a HAI surveillance framework for this project.

An in-depth case study of HAI surveillance implemented in SDHB hospitals has been performed, with a detailed review of the HAI surveillance systems used in SDHB hospitals. The project also includes a review of HAI surveillance performed in other New Zealand DHB hospitals. Key stakeholder interviews were performed with SDHB hospital staff members and a national HAI surveillance questionnaire was developed to review the surveillance systems used for HAIs in other District Health Board (DHB) hospitals. Results from the interviews and questionnaire are presented in chapter six. The results provide a description of the surveillance performed in DHB hospitals as well as a review using the evaluation framework. A discussion of the results obtained along with the study’s strengths, weaknesses and implications are subsequently presented. The thesis finishes with conclusions and recommendations for improving hospital surveillance systems in New Zealand with a focus on SDHB hospitals.
2 Background

This chapter provides background information on the research performed. The section will explain the terms healthcare acquired infections, surveillance systems and the importance of monitoring such infections. An outline of the New Zealand healthcare setting and HAI surveillance in New Zealand is also provided.

2.1 The Public Health Issue

Despite significant gains in recent years, disease caused by infectious agents remains a major cause of death, disability, social and economic disruption for families and communities (Jones et al., 2008). Developed countries including New Zealand are faced with emerging infectious diseases (Weiss and McMichael, 2004). New Zealand is dealing with unusually high rates of particular infections, such as rheumatic fever (Jaine et al., 2008), serious skin infections (O'Sullivan et al., 2011) and meningococcal disease (O’Hallahan et al., 2009). From 1989-2008, infectious disease was the major cause of hospital admission in New Zealand, with its contribution to acute admissions increasing from 20.5% between 1989 and 1993 to 26.6% between 2004 and 2008. The risk of hospitalisation due to infection has increased in the most economically deprived populations, in the young and old population groups and in Maori and Pacific Island peoples. This demonstrates a clear ethnic and social inequality in infectious disease risk (Baker et al., 2012).

It is imperative that already vulnerable patients admitted to hospital do not suffer from any additional preventable harm or adverse event. HAIs are a leading contributor to such events, generating an increase in morbidity and mortality, prolonging hospital stays, increasing antimicrobial resistance and producing substantial healthcare costs through additional diagnostic and therapeutic interventions (Plowman et al., 2001). Various studies have confirmed that HAIs are common and are associated with substantial morbidity, high cost and mortality (Fraser, 2002, García-Martín et al., 2001, Gerberding, 2002).

HAIs can occur in all healthcare settings and are of major public health importance worldwide. A systematic review of literature on endemic HAIs from 1995-2010 conducted by
the World Health Organisation (WHO) showed the prevalence of hospitalised patients who acquired at least one HAI ranged from 3.5-12% in high income counties (WHO, 2011). Data from a 2006 prevalence survey estimated that 5-10% of in-patients in British and Irish hospitals developed a HAI (Smyth et al., 2008). The Centres for Disease Control and Prevention (CDC) estimated in 2002 that 1.7 million HAIs occurred in American hospitals and were associated with approximately 99,000 deaths and cost an additional $20 billion to the nation’s annual healthcare tab (Services, 2012, Klevens et al., 2007a).

The rates of HAIs in New Zealand follow a similar trend to that seen in other developed countries. Graves et al. (2003) found the prevalence in Auckland DHB hospital to be 9.5%, with 553 patients identified with one or more HAIs from a population of 5,819; and the predicted cumulative incidence for all patients was 6.33% (Graves et al., 2003). The overall effect on the New Zealand healthcare system is estimated to cost an excess of NZ$50 million for medical admissions and NZ$85 million for surgical admissions, totalling an extensive NZ$137 million (Burns et al., 2010). Therefore it is critical that measures are implemented to reduce the health, social and economic burden associated with HAIs (Graves et al., 2003).

2.2 Healthcare Acquired and Nosocomial Infections

The term ‘HAI’ covers infections which occur in patients while they are receiving treatment in a healthcare environment and which were not present or incubating on admission (Horan et al., 2008). HAIs are caused by microorganisms - bacteria, fungi, or viruses which can be transmitted through a medical device, or spread by contact or ingestion (Siegel et al., 2007).

HAIs are also referred to as hospital acquired infections or nosocomial infections and these types of infections are associated with admission in acute-care hospitals. The term has since been broadened to include infections acquired in all healthcare settings, including long term care, home care, outpatient surgical centres and ambulatory clinics (Collins, 2008). From the consultation process with SDHB study sponsors, they identified the need to gather information regarding hospital surveillance system for HAIs. This research project has a focus on HAIs occurring in the hospital setting only. With recent literature using the term “healthcare acquired infections” to describe infections acquired in healthcare settings
including hospital settings, the term “healthcare acquired infections” will be used throughout this thesis.

### 2.2.1 Types of Healthcare Acquired Infections

There are a range of agents that are transmissible in healthcare environments, with the types of infection varying in specific groups and in frequency of occurrence. The term HAIs includes endemic and epidemic infections. Endemic HAIs are infections which are usually present in the healthcare setting while epidemic HAIs refer to outbreaks of infections, when there is an increase in the numbers of infection above what is usual. Both endemic and epidemic HAIs can be characterised by the site or system infected or by the organism causing the infection (Emori and Gaynes, 1993). HAIs can be associated with the devices used in medical procedures such as catheters or ventilators. These types of infections include surgical site infections (SSIs), central line-associated bacteraemia (CLAB), ventilator associated pneumonia (VAP) and catheter associated urinary tract infections (cUTIs). HAIs may also be transmitted to patients through contaminated surfaces, equipment, other patients or healthcare workers. These infections may be caused by Methicillin resistant *Staphylococcus aureus* (MRSA) and *Clostridium difficile* (*C. difficile*) which are increasing in incidence in acute care settings, causing significant public health threats (Weinstein et al., 2005).

SSIs occur after surgery in the part of the body where the surgery took place. They can be superficial infections involving the skin only or invasive involving tissues under the skin, organs, or implanted material which are usually more serious (de Lissovoy et al., 2009). CLAB infections are a result of infecting agents entering the bloodstream through a central line (Weber and Rutala, 2011). A central line is a tube that is inserted in a large vein in the neck, chest, or groin to give medication or fluids or to collect blood for medical tests. Intravenous catheters (known as IVs) are used frequently to deliver medication or fluids into a vein near the skin’s surface. IVs are usually inserted on the arm or hand for short periods of time. Central lines are commonly used in intensive care units. The lines access a major vein that is close to the heart and can remain in place for weeks or months and be much more likely to cause serious infection compared to IVs (O’Grady et al., 2002). A urinary catheter is a tube
inserted into the bladder through the urethra to drain urine. A cUTI is a result of the catheter becoming contaminated with microorganisms causing an infection in the bladder, urethra, kidneys or any part of the urinary system (Hooton et al., 2010). VAP is a lung infection that develops in a person who is on a ventilator. A ventilator is designed to assist a patient with breathing; it is a tube that is placed in the mouth or nose, or through a hole in the front of the neck of a patient. An infection may occur if infectious agents (usually bacteria or viruses) enter through the tube and into the lungs of the patient (Craven and Hjalmarson, 2010). Multidrug-resistant organisms are infectious agents that have become resistant to the medicine used to treat them. MRSA is a type of *Staphylococcus* bacteria that is resistant to certain antibiotics called beta-lactams (Boyce, 1992). *C. difficile* is a bacterium that can cause gastrointestinal infection. Hospital patients can be exposed to infection through contaminated surfaces or the spores can be transferred through contact (McDonald et al., 2012).

The four most common types of hospital acquired infections identified by Weinstein et al (2005) in no particular order are pneumonia, SSIs, UTIs and blood stream infections (BSIs). These results are based on early research investigating the epidemiology and control of nosocomial infections (Weinstein, 1991). MRSA and *C. difficile* infections (CDIs) are the most significant types of HAIs attributed to specific organisms (Sprague, 2009). The different types of HAIs can be ranked according to their occurrence, associated mortality rates and economic costs. The most common type of HAI are cUTIs, but these infections carry the lowest mortality rate and lowest cost. SSIs are the second most frequent type of HAI and contribute to about a third of the cost. BSIs and pneumonia are less common but are associated with much higher mortality. BSIs and MRSA infections are widely recognised as high cost infections that are increasing in frequency (Burke, 2003). The latest findings from the CDC report that CLAB, cUTIs and VAP account for roughly two-thirds of all HAIs (CDC 2013). The estimates of HAIs vary in the literature. Table 1 shows percentage estimates of the main HAIs at different time periods; values are adopted from the National Nosocomial Infection Surveillance (NNIS) system, a full description of the NNIS system is provided in chapter 3 (Weinstein, 1998, Burke, 2003, Klevens et al., 2007a). UTIs have been the most common type of HAI during all three time periods followed by SSIs and respiratory and BSIs have been similar in frequency. Based on the data presented in table 1, interpretation on the
occurrence of specific HAIs through time cannot be made as the criteria of the subgroup population under review differ. All hospital patients are included in Burke (2003), ICU patients are excluded in Klevens et al. (2007), and the patient group used in the analysis performed by Weinstein (1998) was not stated. The main types of HAIs identified (CLAB, SSIs, VAPs, cUTIs, MRSA and C. difficile) are all of public health significance and have the potential to be prevented through evidence based practice (Yokoe et al., 2008).

Table 1. Percentage estimate of HAIs

<table>
<thead>
<tr>
<th>Source and year</th>
<th>UTI</th>
<th>SSI</th>
<th>Respiratory tract infections (pneumonia)</th>
<th>BSI</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subgroup of US hospitals from 1975 using the NNIS System (Weinstein, 1998).</td>
<td>42%</td>
<td>24%</td>
<td>10%</td>
<td>5%</td>
<td>19%</td>
</tr>
<tr>
<td>Subgroup of US hospitals using hospital-wide component NNIS System from 1990-1996 (Burke 2003).</td>
<td>34%</td>
<td>17%</td>
<td>13%</td>
<td>14%</td>
<td>21%</td>
</tr>
<tr>
<td>Estimates in subgroup of US hospitals outside of ICU using NNIS in 2002 (Klevens 2007).</td>
<td>36%</td>
<td>20%</td>
<td>11%</td>
<td>11%</td>
<td>22%</td>
</tr>
</tbody>
</table>

2.3 Risk factors and predisposing factors for HAIs

Many patients in hospital are intrinsically vulnerable to infection: patients are often at the extremes of ages (i.e. very young or old), they are debilitated, patients may have an underlying illness causing immunodeficiency, and skin disease and bed sores allow for infecting organisms to enter subcutaneous tissue. The normal microflora of all patients includes potential pathogens from the gut such as E.coli, and from the nose such as Staphylococcus aureus (S.aureus), that can cause infection in compromised patients. Surgical incisions and intravascular devices produce an opportunity for pathogen entry (Breathnach, 2005). Indwelling devices including catheters, prosthetic joints and heart valves, and devices such as ventilators provide a protected niche for bacterial growth. Medical interventions such as immunosuppressive therapy after transplantation surgery, and antibiotic treatment which may alter the patients’ normal microflora, allows for even
low virulence organisms to be dangerously pathogenic. The hospital environment also poses a risk of infection to patients. Patients may become sick due to organisms transmitted from other patients, staff or the environment. Overcrowded conditions, understaffing and poor hand hygiene increase the risk of cross-infection amongst hospital patients (McFee, 2009). Neonates have an immature immune system making them susceptible to infection; they are also exposed to extrinsic risk factors associated with healthcare facilities such as central venous catheters and surgical procedures (Newby, 2008).

2.4 Prevention of HAIs
A review performed by Harbarth et al. (2003) analysed intervention studies that aim to reduce preventable HAIs. A range of interventions were used by hospitals including education programmes, disinfection and hygiene programmes and a key common programme involved surveillance with the feedback of information to relevant personnel. A range of interventions were used by hospitals including education programmes, disinfection and hygiene programmes, and programmes involving surveillance with the feedback of information to relevant personal (which were the most common programmes). The study showed that infections were able to be reduced by 10-70% depending on the setting, study design, baseline infection rates and the type of infection (Harbarth et al., 2003). The most successful accounts of reducing HAIs involved a multifaceted, multidisciplinary and multi-model intervention approach, combining education, control procedures and surveillance detection programmes (Abbett et al., 2009). HAIs can be dramatically reduced with infection control activities; and surveillance plays an important part in these activities (Klevens et al., 2007a).

2.5 Surveillance of HAIs
Surveillance is defined as “the on-going, systematic collection, analysis, and interpretation of health data essential to the planning, implementation, and evaluation of public health practice, closely integrated with the timely dissemination of data to those who need to know.” Surveillance activities include data collection, data analysis, interpretation and dissemination of results (Declich and Carter, 1994). The importance of HAI surveillance and control programmes has been emphasised for some time, with efficient surveillance
identified as the cornerstone of efforts to control infection (Gaynes et al., 2001). Regular monitoring and review of HAI surveillance data provides opportunities for tracking trends, providing quality outcome indicators, and identifying actions to reduce the burden of HAIs (Kilpatrick and Reilly, 2002). Surveillance followed by improvements can produce considerable reductions on rates of HAIs (Gaynes, 1997).

The 1985 CDC project called the Study on the Efficacy of Nosocomial Infection Control, known as the SENIC study, demonstrated that HAI surveillance in combination with prompt feedback and appropriate infection control programmes is able to significantly decrease HAI rates (Haley et al., 1980). These results have been recently validated in Germany where they showed that participation in a nationwide nosocomial infection surveillance programme involving an integrated infection control programme, with HAI surveillance was associated with a significant reduction in HAIs (Gastmeier et al., 2006). Similar results have been demonstrated in recent literature (McLaws et al., 2000, Tokars et al., 2004, Morton et al., 2008). Many healthcare facilities are now routinely collecting standardised data on HAIs allowing for internal performance tracking and comparisons between local healthcare facilities and international benchmarks (O'Neill and Humphreys, 2009).

2.6 The New Zealand Context

2.6.1 National Setting

The New Zealand health care system is centred on 20 geographically defined District Health Boards (DHBs). The DHBs are funded by the Ministry of Health and are responsible for planning, purchasing and providing health and disability support services to New Zealanders in their geographic area (Gauld, 2012b). The DHBs were established in 2001 under the New Zealand Public Health and Disability Act 2000. Each DHB varies in size, structure, approach and are funded according to the size and demographic mix of their population i.e.- age, gender, ethnicity and deprivation as well as the population’s past use of health services (Ministry of Health, 2013a). Figure 1 shows a map of New Zealand illustrating the 20 DHBs and their location.
DHBs provide a range of health services covering preventive care, inpatient and outpatient hospital care, primary care services (excluding optometry, adult dental services and orthodontics), inpatient and outpatient prescription drugs, mental healthcare, dental care for school children, long-term care, and disability support services. The annual budget for the various publicly funded health services and the national service requirements for the 20 DHBs are set by the government and rationing and prioritisation occurs internally and may vary between each DHB (Gauld, 2012b). There are public and private hospitals in New Zealand, the public hospitals provide emergency and intensive care services and are run and owned or funded by DHBs with some DHBs having one or several hospitals in a particular area (Ministry of Health, 2011). Table 2 shows the 20 DHBs, the total population in the DHB area, the central hospital located in the DHB area based on where the DHB headquarters are and the amount of funding provided by the Ministry of Health in 2013/14.

There are a number of government-funded and appointed entities in the health care system. Some entities support consumers’ rights within the health sector such as the Health and Disability Commission. Other groups are Crown Entities that have their own boards and are reviewed annually with requirements to meet government expectations (Gauld, 2012b). The National Health Board was established in November 2009 by the New Zealand Government with the aim to overcome the challenges facing the New Zealand health system and improve the quality, safety and sustainability of healthcare for New Zealanders (National Health Board, 2012). The National Health Board Business Unit now services national agencies to address new and on-going health challenges. The Health Information Technology Board was created which to ensure that health sector policy is supported by appropriate health information and IT solutions across the health and disability sector (Gauld, 2012b). The Health Quality and Safety Commission (HQSC) was designed to support and stimulate quality improvements activities across the health sector (Gauld, 2012a). The HQSC is categorised as a Crown agent, and under the New Zealand Public Health and Disability Act 2000 the commission have the objectives of “monitoring and improving the quality and safety of health and disability support services” and “helping providers across the health and disability sector to improve the quality and safety of health and disability support services” (Commission, 2013b).
Figure 1 Map of New Zealand showing the 20 DHBs and their geographic areas
(Ministry of Health, 2013a)
### Table 2. Characteristics of DHB Hospitals

<table>
<thead>
<tr>
<th>DHB</th>
<th>Main hospital</th>
<th>DHB Population (2013/14)</th>
<th>Funding provided by the Ministry in 2013/14 (million $NZ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northland</td>
<td>Whangarei Hospital</td>
<td>159,795</td>
<td>$470.6 million</td>
</tr>
<tr>
<td>Waitemata</td>
<td>North Shore Hospital</td>
<td>562,970</td>
<td>$1253.3 million</td>
</tr>
<tr>
<td>Auckland</td>
<td>Auckland City Hospital</td>
<td>469,400</td>
<td>$1069.8 million</td>
</tr>
<tr>
<td>Counties Manukau</td>
<td>Middlemore Hospital</td>
<td>516,050</td>
<td>$1202.8 million</td>
</tr>
<tr>
<td>Tairawhiti</td>
<td>Gisborne Hospital</td>
<td>46,753</td>
<td>$140.0 million</td>
</tr>
<tr>
<td>Waikato</td>
<td>Waikato Hospital</td>
<td>373,220</td>
<td>$966.6 million</td>
</tr>
<tr>
<td>Bay of Plenty</td>
<td>Tauranga Hospital</td>
<td>214,910</td>
<td>$592.2 million</td>
</tr>
<tr>
<td>Lakes</td>
<td>Rotorua Hospital</td>
<td>103,170</td>
<td>$270.8 million</td>
</tr>
<tr>
<td>Taranaki</td>
<td>New Plymouth Hospital</td>
<td>110,258</td>
<td>$296.6 million</td>
</tr>
<tr>
<td>Hawke’s Bay</td>
<td>Hastings Hospital</td>
<td>156,490</td>
<td>$425.4 million</td>
</tr>
<tr>
<td>Whanganui</td>
<td>Wanganui Hospital</td>
<td>62,630</td>
<td>$197.9 million</td>
</tr>
<tr>
<td>Mid Central</td>
<td>Palmerston North Hospital</td>
<td>170,200</td>
<td>$444.1 million</td>
</tr>
<tr>
<td>Hutt Valley</td>
<td>Hutt Hospital</td>
<td>145,215</td>
<td>$345.8 million</td>
</tr>
<tr>
<td>Capital and Coast</td>
<td>Wellington Hospital</td>
<td>299,720</td>
<td>$660.7 million</td>
</tr>
<tr>
<td>Wairarapa</td>
<td>Masterton Hospital</td>
<td>40,735</td>
<td>$119.1 million</td>
</tr>
<tr>
<td>Nelson Marlborough</td>
<td>Nelson Hospital</td>
<td>141,933</td>
<td>$366.7 million</td>
</tr>
<tr>
<td>West Coast</td>
<td>Greymouth Hospital</td>
<td>32,055</td>
<td>$116.1 million</td>
</tr>
<tr>
<td>Canterbury</td>
<td>Christchurch Hospital</td>
<td>509,860</td>
<td>$1218.5 million</td>
</tr>
<tr>
<td>South Canterbury</td>
<td>Timaru Hospital</td>
<td>56,695</td>
<td>$160.6 million</td>
</tr>
<tr>
<td>Southern</td>
<td>Dunedin Hospital</td>
<td>309,028</td>
<td>$756.4 million</td>
</tr>
</tbody>
</table>

Source: (Ministry of Health, 2013a).

#### 2.6.2 Southern District Health Board

Southern District Health Board (SDHB) was formed in May 2010 as the result of a merger between Southland and Otago DHBs. SDHB covers the lower South Island area and has a population size of over 304,268. SDHB are responsible for planning, funding and providing health and disability services to the areas encompassing Invercargill, Queenstown, Gore, rural Southland, Clutha, Central Otago, Waitaki District and Dunedin City. According to data from 2011, the demographic profile of SDHB tends to be slightly older than the national average, with a higher proportion of those aged over 65 years. There are also a higher
proportion of young adults (15-24 year olds). The SDHB population is predominantly European/other ethnicity (77%) with a lower proportion of Maori (8%) and Pacific Island (1.5%) people, but a similar proportion of Asian people (3%) compared to other areas of New Zealand (Ministry of Health, 2013b). SDHB has a high proportion in the least deprived section of the population and a low proportion in the most deprived section when compared to the national average (Ministry of Health, 2013b).

Approximately half of the government funding is applied to traditional hospital and mental health services delivered from the Otago Provider Arm hospitals which include four hospitals in SDHB: Dunedin Public Hospital and Wakari Hospital both located in Dunedin, Southland Hospital is located in Invercargill and Lakes District Hospital is located Queenstown (Southern District Health Board, 2013).

2.6.3 HAI surveillance in New Zealand

The development of a national HAI surveillance programme in New Zealand has been considered by the Ministry of Health from the early 1990s. A proposed programme called Reducing Infection through Surveillance and Knowledge was scheduled to be directed by ESR and Medlab South in the late 1990s; however the project was deemed prohibitive in cost and did not reach implementation (National Quality Improvement Programme, 2010).

The 2003 Controller and Auditor-General New Zealand report found that all hospital services undertook some form of surveillance, such as monitoring laboratory samples for significant organisms. However, hospital services lacked a comprehensive surveillance programme for infections associated with complex surgery. Hospital Infection Prevention and Control Teams were found to be selective in their reporting of surveillance data to clinical staff in order to avoid burdening them with non-essential information. Some infection control teams were neglecting entirely to report this data to them and not all infection control teams were providing periodic surveillance reports to quality managers. A total of 39 recommendations were outlined in the report to improve the management of HAI; one recommendation suggested that the Ministry of Health in collaboration with
DHBs should develop guidelines on how and to what extent surveillance data should be collected (Controller and Auditor General Office, 2003).

The economic cost associated with BSIs was estimated in Auckland City Hospital. Two patient groups were evaluated who developed a hospital acquired BSI. Group 1 included all patients who acquired a BSI that were admitted to hospital within the study period, group 2 included haemodialysis central line-related hospital acquired BSIs. The average excess cost associated with hospital acquired BSIs in group 1 was $20,394 and was $11,139 for group 2, an episode of hospital acquired BSI increased the length of hospital admission by 9.7 days and 7.9 days respectively, emphasising the substantial cost associated with hospital acquired BSIs (Burns et al., 2010).

Various programmes have been developed by the HQSC from medication safety to reducing harm from falls. An infection prevention and control programme has also been developed. The Commission is currently working on three projects in the IPC area. The Hand Hygiene New Zealand programme was initially established by the Quality Improvement Committee and is now delivered by the HQSC. The programme aims to increase awareness among healthcare workers about the importance of hand hygiene in improving patient safety and improve healthcare worker hand hygiene compliance (Hand Hygiene NZ, 2012). Improvements in healthcare worker compliance in the hand hygiene programme has led to reduction in the healthcare associated S. aureus-BSI rates in Auckland DHB (Roberts et al., 2012).

The HQSC has entered into partnership with Ko Awatea to facilitate a national collaborative to prevent CLAB infections. Ko Awatea is the Centre for Health System Innovation and Improvement for Counties Manukau DHB (Ko Awatea, 2013). The “Target CLAB Zero” initiative aims to reduce the rate of CLAB in New Zealand intensive care units towards zero (<1 per 1000 line days), through the use of CLAB bundle of care packages maintenance checklist (Commision, 2013a).

The Surveillance of Surgical and Procedural Site Infection programme is the third IPC programme developed by the HQSC which aims to develop an evidence-based surveillance
system and approach that drives the continuous improvement and reduction of SSIs throughout New Zealand. A series of recommendations for national surgical site infection (SSI) surveillance were developed after the consultation process. These recommendations aim to:

- Bring New Zealand in line with other developed counties who have established national HAI surveillance systems.
- Allow DHB hospitals to compare SSI rates and improve accountability.
- Generate substantial economic savings to the healthcare system providing opportunities for priority areas (National Quality Improvement Programme, 2010).

The New Zealand Australasia Sapere Research group investigated the cost benefits to a national surgical site infection surveillance programme and found that a national SSI programme is highly likely to lead to significant reductions in SSI rates. The financial case for a SSI surveillance programme is positive. An automated SSI surveillance programme is likely to cost around $4.4 million to introduce, with an approximate $1 million per year for ongoing maintenance cost. After a 10 year investment in the surveillance programme the most likely outcome is a positive net present value (difference amount) of $0.9 million (Hefford et al., 2011)

New Zealand is in its infancy of developing a national surveillance programme with the focus on surgical site infections. The New Zealand Health and Safety Commission are leading the national surgical surveillance programme. In March 2013 the programme was in its pilot stages with Auckland and Canterbury DHB in partnership with the Commission leading the programme. National implementation of the programme is scheduled for July 2013. The first step of the programme was to implement the surveillance system for hip and knee arthroplasty in 8 DHBs; other surgical procedures are to be incorporated over the next one to two years. The surveillance programme will use a software programme called ICNet, which incorporates an online data collection form for the manual entry of DHB SSI surveillance data. The ICNet data collection form will ensure that healthcare professionals have access to standardised and comparable information, allowing them to drive continuous improvements in clinical practice. The surgical site infection surveillance programme is part
of an infection control prevention and control programme coordinated by the Health Quality and Safety Commission (Health Quality & Safety Commision, 2013).

In October 2012 the Healthcare Associated Infections Governance Group (HAIGG) conducted a survey to obtain information on the current infection prevention and control capability of the healthcare system. The HAIGG provides national leadership and sets direction for the Ministry of Health on HAIs (personal communication G.Storey, Ministry of Health 2013). The IPC capability survey received responses from every DHB. A summary of the results from the IPC capability survey is outlined below:

- HAI surveillance appears to be a mixture of electronic and manual systems and judging from comments it appears variable, cumbersome and the data is probably not comparable.
- 74% reported undertaking all of the following clinical surveillance activities: (1) The Hand Hygiene New Zealand programme, (2) CLAB, (3) SSI, (4) BSI, (5) MDROs, (6) C.difficile.
- Of the DHBs that did not perform all of the above surveillance activities, 9% reported performing 5/6 surveillance activities, 4% reported performing 4/6 activities, 4% also reported performing 3/6, and 9% reported performing 2/6 activities.
- 30% reported inability to link laboratory HAI surveillance with clinical outcomes with 9% not reporting.

2.7 Reports and Documents Presenting New Zealand HAI Information

2.7.1 Health Roundtable Reports

The Health Roundtable organisation was established in 1995 and has operated as a non-profit collaborative organisation, with the aim to “provide opportunities for health executives to learn how to achieve best practice in their organisations. To collect, analyse and publish information comparing organisations and identifying ways to improve operational practices as well as to promote interstate and international collaboration and networking amongst health organisation executives” (Health Roundtable, 2012a)
A total of 134 facilities across Australia and New Zealand are members of the Health Roundtable organisation and provide data for comparative analysis. The data provided to the organisation is available to participating members, but is not disclosed to outside organisations. All members of the Health Roundtable must abide by the Health Roundtable code which outlines that members shall not criticise the performance of other organisations or use the shared information to the detriment of a fellow member. The external distribution or conclusions made by the Health Roundtable data is not made without the unanimous consent of all contributors, unless required by law. The Health Roundtable produces reports to hospital CEOs and quality groups to allow for improvement in collaborations, networking and the establishment of best practice. The Health Roundtable organisation uses standardised risk adjusted methodology focusing on outcomes. Through initial consultation with SDHB study sponsors, it was expressed that data concerning HAIs is assembled from patients’ clinical records and submitted to the Health Roundtable (Health Roundtable, 2012b).

2.7.2 Global Trigger Tool Report

The Global Trigger Tool programme is an international quality improvement initiative established in 2003 by the Institute for Healthcare Improvement (IHI) (Cambridge, Massachusetts, USA). The programme aims to reduce patient harm caused by errors in hospital and provides an easy-to-use method for accurately identifying adverse events or harms and measuring the rate of adverse events over time. A retrospective method is used, whereby a random sample of inpatient hospital records are reviewed using ‘triggers’ or clues to identify possible adverse events, rather than relying on people to report errors. This tool can be used to identify events, to assess the level of harm from each event and to determine whether adverse events are reducing due to improvement efforts. Healthcare acquired infections are a common cause of adverse events and rates of infection can be monitored through the Trigger Tool. However, the programme is not intended to identify every single adverse event in an inpatient record; the random selection of records and the recommended time limit for review are designed to produce a sampling approach that is sufficient to determine harm rates and observe improvement over time (Griffin and Resar, 2009).
The HQSC are developing a work programme to help implement the Global Trigger Tool programme in New Zealand. The Commission is encouraging all DHBs to implement the Global Trigger Tool initiative. At the time of consultation with study sponsors SDHB had begun piloting the Global Trigger Tool programme in both Southland and Dunedin hospitals (Health Quality & Safety Commision, 2012).

2.7.3 Australasian Indicator Report

The Australasian Clinical Indictor Report (ACIR) programme, previously known as the Care Evaluation Programme, is operating within the Australian Council on Healthcare Standards (ACHS). The ACHS is a legal accreditation agency who are authorised to accredit healthcare organisations to the National Safety and Quality Health Service Standards (NSQHSS). The ACIR programme first started in 1993 and remains the largest clinical data set on quality healthcare in Australia and New Zealand. The programme acts as a data repository, analysis and reporting service to more than 700 participating healthcare organisations in Australia and New Zealand. Submission of data is voluntary and organisations can submit data monthly, three-monthly or six-monthly with most organisations making two submissions for their selected indicators per year. The data is then analysed and each contributing healthcare organisation receives general and peer comparison reports every six months. The indicator sets include broad range hospital-wide areas from anaesthesia to rehabilitation medicine with a total of 22 sets; an infection control indicator is also included. A clinical indicator is used to measure the clinical management and/or outcome of care and can identify clinical issues. By identifying variations within data results, the indicators are designed to indicate potential problems that may need to be addressed. They are used to assess, compare and determine the potential to improve patient care. The infection control indicator set covers six areas. These are SSIs, CLAB infections, haemodialysis associated BSI surveillance, neonatal infections, healthcare-associated MRSA morbidity, and occupational exposures to blood and/or body fluids. Each of the infection control areas are further categorised into infection groups, for example adult ICU CLAB infections, hip prosthesis surgical procedure, non ICU-associated new MRSA inpatient HAIs in a sterile site, etc. Infection surveillance data for the six areas of infections are collected and rates of infections are calculated and trends are detected(Australian Council on Healthcare Standards, 2012).
2.8 Background summary

HAIs are infections that occur in a patient during the process of medical care which was not present or incubating at the time of admission. They are of major public health importance worldwide and in New Zealand, with around 3.5-10.5% of hospitalised patients in the developed world acquiring an infection as a result of their hospital stay. The main types of HAIs are CLAB, SSIs, VAPs, cUTIs, MRSA and *C. difficile*, all of which are significant and lead to increases in morbidity and mortality rates of in-patients, generate extensive additional burden for hospital systems and economic costs. Therefore, it is essential that effective prevention and control measures are implemented in hospitals. The foundations of such programmes involve HAI surveillance followed by quality improvements. Surveillance involving the on-going systematic collection, analysis and interpretation of data has been identified as an important way to provide outcome indicators and determine key measures in order to reduce the burden of HAI. In New Zealand there are a number of reports detailing HAI rates and numbers but no nationally co-ordinated system.
3 Literature Review

3.1 Introduction
The importance of HAI surveillance has been recognised for decades. There is a significant amount of literature supporting the value of HAI surveillance. However, the methods, concepts and implementation of such systems differ according to the context, resources available, and hospital management ideologies. In order to understand the approach to HAI surveillance in DHB hospitals and to assist the development of semi-structured interview questions and the national surveillance survey a review of the literature was undertaken.

3.2 Objectives
The objectives of the literature review were:

- To identify the fundamentals of HAI surveillance systems, in terms of their core components, method’s strengths and weaknesses.
- To identify and review HAI surveillance systems used in developed countries and to establish best practice.
- To review frameworks for the evaluation of HAI surveillance and to adopt a HAI surveillance framework for this project.

3.3 Methods

3.3.1 Data sources
The following data sources were used for the literature review:

- Medline via Ovid (1950-present)
- PubMed
- Google Scholar
- University of Otago library catalogue

The grey literature used in this literature review includes:

- Ministry of Health reports
- Health Quality and Safety Commission reports
• World Health Organisation reports
• The Centres for Disease Control and Prevention documents
• Government websites, including DHBs websites

The Health Round Table and National Health Board registers were also used in the literature review. The reference lists of obtained articles and reports were also reviewed for relevant documents.

3.3.2 Search terms

An initial scan of the literature was performed using the key terms and their truncations “hospital associated infection/s” in conjunction with “surveillance system/s”. Once additional key words were gained the search terms were extended to include the following terms: “healthcare acquired infection/s”, “healthcare associated infection/s”, or “nosocomial infection/s”, or “device associated infection/s” or “hospital associated infection/s” or “hospital acquired infections” and “surveillance” and “hospitals”. To identify relevant reports and articles concerning evaluation frameworks, the following search terms were added to the above: “framework/s”, “evaluation”.

3.3.3 Inclusion and exclusion criteria

Articles were excluded if the countries under investigation are part of the developing world, i.e.- only surveillance systems used in the developed world were included for review. Articles that were not written in English were excluded. Due to the timing of research, only articles prior to May 2013 were included. HAI surveillance systems concerning long term care facilities were not included for review. This excluded articles dealing with rest homes, psychiatric units and rehabilitation centres. Only surveillance systems for HAIs in patients were investigated, i.e.- there was no investigation into healthcare acquired infection monitoring of healthcare workers, occupational health, and needle stick injuries. Table 3 outlines the reasons behind the inclusion and exclusion criteria.
Table 3. Rationale of inclusion and exclusion criteria for literature review articles

<table>
<thead>
<tr>
<th>Inclusion criteria</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articles written in English</td>
<td>Obtaining a translator for various languages would require resources that were unavailable.</td>
</tr>
<tr>
<td>Articles published prior to May 2013</td>
<td>The literature review search was carried out before April 2013</td>
</tr>
<tr>
<td>Articles concerning high income countries (World Bank definition of a high income country is used)*</td>
<td>Developing countries do not have access to the resources and technologies that are available in the developed world. Therefore the types of surveillance systems used in developing countries may not be appropriate and comparable given the resources available in New Zealand.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exclusion criteria</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articles discussing HAI surveillance in long term care facilities or other healthcare facilities including with the exception of hospitals.</td>
<td>DHB hospitals in New Zealand are sub-acute, secondary or tertiary hospitals. Therefore for the purposes of generating appropriate comparisons and recommendations, institutions need to be comparable.</td>
</tr>
<tr>
<td>Case study articles looking at specific infection outbreaks in hospitals.</td>
<td>The literature review objectives focused on identifying the different objectives, components and methods of HAI surveillance and other systems used in other developed countries. Comparing rates of infections and outbreaks of HAIs was not required in terms of the literature review.</td>
</tr>
<tr>
<td>Clinically or microbiologically focused articles</td>
<td>Articles concerning clinical surveillance of HAIs were inclined to focus on the etiology of specific strains of infection and were not relevant to the research objectives.</td>
</tr>
</tbody>
</table>

* The World Bank organisation divided countries into high, middle and low income categories according to their Gross National Income (GNI) per capita per year. Countries with GNI of US $12,616 or more in 2012 are defined as a high income country (The World Bank, 2013).

3.3.4 Results

Using the previously stated databases and search terms, a substantial number of articles were obtained. The title and abstracts of such articles were reviewed and the suitability determined based on the relevance to stated objectives and inclusion and exclusion criteria. An example of the search performed in Ovid Medline is shown in Figure 2.
The title and abstracts of the 96 identified articles were reviewed and 41 articles were subsequently excluded according to exclusion criteria. These excluded articles either had a focus on case study outbreak investigation, were microbiological or clinically orientated, or grounded in a developing country. A remaining 55 articles were reviewed from the Ovid Medline database.

Figure 2. Search Strategy example used on Ovid Medline for finding relevant articles
3.4 Literature review objective one

This section reviews the fundamentals of HAI surveillance. It explains the key components of HAI surveillance, which concerns establishing objectives for HAI surveillance, the definitions for the different types of HAIs, the methods used for data collection and analyses for HAI surveillance, the dissemination of information, and the benchmarking of results. The utilisation of computer databases and programmes are also discussed.

3.4.1 Introduction to HAI surveillance

The United States of America was the first country to develop hospital-based programmes for the prevention, control, and monitoring of HAI. Predominantly as a result of a staphylococcus epidemic that swept the nation in the late 1950s, the CDC in collaboration with the National Academy of Science hosted a national conference in the US in 1958 with the aim to control hospital-acquired staphylococcal disease (Anderson, 1958). It was concluded that hospital infection control committees should be established who have responsibilities for infection control, educating hospital personnel, and the surveillance of hospital infections. The development of a HAI surveillance system was regarded as key element, but also one of the most challenging components of the hospital infection control programme (Dowling et al., 1958).

Nosocomial infection prevention and control programmes were subsequently developed and refined in the 1960s and 1970s. Prior to the development of a national programme in the US, surveillance studies were conducted in individual hospitals to help estimate the rate of nosocomial infections (Kislak and Eickhoff, 1964). The CDC was involved in a comprehensive infection project involving several hospitals during 1969 to the early 1970s (Bennett et al., 1970). The project led to the development of uniform definitions and methods for the detection of nosocomial infection. It was also recommended by the CDC that all hospitals establish positions for a hospital epidemiologist and infection control nurse (Hughes, 1987).

The NNIS was developed in 1970 by the CDC; hospitals were able to participate voluntarily but were required to conduct active hospital-wide surveillance on all patients who stayed at least overnight using uniform definitions for HAIs at all sites (Horan et al., 1986). In order to understand the efficacy of infection control programmes, the CDC initiated a project to
examine the effectiveness of nosocomial infection surveillance and control programmes in accredited hospitals known as the Study on the Efficacy of Nosocomial Infection Control (SENIC). A series of investigations were performed between 1974-1983, with the first study published in 1980 the methodology of the SENIC (Eickhoff, 1980, Haley et al., 1980). The key objectives of the SENIC project were: to measure the extent of newly developed infection control programmes that had been adopted in US hospitals and to determine whether and to what degree the infection control programmes had reduced nosocomial infection rates (Haley et al., 1980). The initial phase of the SENIC was an observational study using a screening questionnaire involving more than 600 hospitals. Questions were asked to gather information on the utilisation of four infection control programmes: surveillance, control involving disinfection, a dedicated infection control officer or nurse, and a physician or microbiologist involved in the infection control programme. The second phase of the project used a hospital-based interview involving 433 hospitals from the initial group of participants. The third phase included 338 hospitals, who were involved in a retrospective chart review. The final phases aimed to determine the exact nature of the implemented infection control programmes and to measure the nosocomial infection rates in each hospital one year prior to the infection control programme and five years later (Haley et al., 1980).

The results of the SENIC project illustrated that the three essential elements to an effective infection control programme involve surveillance, control, and the feedback of nosocomial infection rates to hospital personnel. If any of the three essential elements were missing from the infection control programme no reduction in nosocomial infection rates was observed. Hospitals that incorporated the three essential elements along with the involvement of a physician or microbiologist were able to reduce nosocomial infection rates by 32%; while hospitals with no infection control programme experienced an increase in nosocomial infection rates. Different combinations of infection control activities were required for the reduction of nosocomial rates at all four specific sites- SSIs, pneumonia, UTIs, BSIs. However, surveillance was found to be the only component essential for the reduction for all four infection types.

In 1983 the questionnaire used in the first phase of the SENIC project was re-sent to randomly selected US hospitals. The questionnaire was used to assess changes in infection
control programmes in individual hospitals. The results of the study found that hospitals had significantly increased their HAI surveillance and control activities. Furthermore, the study showed that HAI surveillance and an effective infection control programme could substantially reduce hospitalisation cost (Haley et al., 1985a).

Results from the SENIC project revealed that surveillance was an essential element for an effective infection control programme. The key elements contributing to the success of the SENIC project included conducting organised surveillance with the involvement of an infectious disease physician, an infection control nurse per 250 beds and with information feedback to concerning infection rates to practicing clinicians. The project established the scientific basis for the use of surveillance in reducing the rate of nosocomial infections, producing important implications for the organisation and funding of care in hospitals. It was concluded by the investigators of the SENIC project that additional studies were required to determine more efficient methods to conducting surveillance (Haley et al., 1985b).

3.4.2 Components of HAI surveillance systems

HAI surveillance identifies issues which can subsequently be addressed and enables healthcare workers to comprehend the magnitude of the problem and what actions are needed (WHO, 2010). Components of the surveillance include data collection and analysis, feedback/dissemination and prevention and evaluation. Pottinger et al. (1997) provide an overview of the basics of surveillance involving the components of a surveillance system including case definitions, data collection, management analysis, and the communication of results. This section will highlight the key components of HAI surveillance which are critical to success.

3.4.3 Objectives of HAI surveillance systems

The success of hospital surveillance programmes can be obstructed by undefined objectives. Surveillance without clear objectives does not impact rates of HAI appreciably (Rasley, 1989). Surveillance of HAI identifies the problem, the size of the problem, and relevant risk factors; it then allows for the prioritisation of limited hospital resources (McLaws, 2011).
Various reports and articles describe the objectives of HAI surveillance, Rasley (1989) identifies that surveillance systems should aim to identify outbreaks and epidemics; evaluate the appropriateness and effect of isolation and precautions; identify problems with procedures, policies, practice, and equipment; report communicable disease to local government; track resistant organisms and call them to the attention of the unit staff; identify patients with resistant organisms on readmission; and check organism sensitivity to antibiotics in use and remind staff of resistance. These objectives are analogous to objectives identified by McLaws, (2011). The WHO incorporates the key areas stated in the literature and describes the objectives of a surveillance programme as the following: to improve awareness of HAIs and antimicrobial resistance among clinical staff and other hospital worker including administrators so that they appreciate the need for prevention; to monitor trends including the incidence, distribution, prevalence and risk-adjusted incidence; to identify the need for new or intensified prevention programmes and evaluate the impact of prevention measures; to identify possible areas for improvement in patient care, and for further epidemiological studies (WHO, 2002).

HAI objectives are simplified by Gastmeier et al. (2000), who summarise surveillance objectives into three main purposes:

- To increase sensitivity to infection control problems and determine areas with possible infection control problems.
- To confirm possible infection control problems.
- To analyse reasons for infection control problems. This would be used if an outlier status for a special unit or department has been confirmed.

Gastmeier et al. (2000) further explains that it is useful to develop surveillance with extensive recording of risk factors for a limited time period, followed by the calculations of risk ratios, allowing for improvements to be made. Depending on the healthcare facility and priorities in infection control the objectives of HAI surveillance may vary. However, regardless of the specifications of the HAI surveillance objectives, the fundamental objective of HAI surveillance is to reduce HAIs and their cost.
3.4.4 HAI definitions

The definitions used for HAIs should distinguish between HAIs and community-acquired infections. The generic definition of a HAI used by many organisations worldwide is:

“An infection occurring in a patient during the process of care in a hospital or other health care facility which was not present or incubating at the time of admission. This includes infections acquired in the health care facility but appearing after discharge and also occupational infections among health care workers of the facility” (Ducel et al., 2002: p.1).

Infections developing 48 hours after admission is the typical cut-off point to distinguish between a HAI and a community-acquired infection (Horan et al., 2008, WHO, 2002, Centers for Disease Control and Prevention, 2009).

It is important that staff members performing surveillance adhere to definitions that are exact, concise, non-ambiguous, and are applied consistently. The reliability and validity of the definitions of HAIs are important concepts in HAI surveillance; systematic errors can be reduced by using standardised methods leading to consistent use of definitions. Rates of HAIs will vary according to the definitions used and comparisons should only be made within the healthcare facility and externally if the same set of definitions have been applied and consistently in the same manner (McLaws, 2011).

Well established criteria have been developed by the CDC which are used in NNIS system and the reformed NHSN. A detailed description of this surveillance system is provided in section 3.5.1. The CDC defines an HAI as a localised or systemic condition resulting from an adverse reaction to the presence of an infectious microorganism or its toxin that occurs during a hospital admission, for which there is no evidence that the infection was present or incubating at admission and meets body site-specific criteria (Horan et al., 2008).

A HAI can be caused by an infectious agent from endogenous sources - body sites such as the skin, nose, mouth, or gastrointestinal tract that are part of the normal micro flora of the body; or from exogenous sources - part of the patients’ external environment such as medical devices, patient care equipment or hospital personnel (Garner et al., 1988). The CDC
has developed a series of considerations as well as set criteria for specific types of infections which can be used as a reference by infection prevention control staff when determining if the identified infection is a HAI. The specific HAIs have been categorised into 13 groups to facilitate data analysis. Each major infection type is divided into several categories. For example, there are three specific types of UTIs; symptomatic UTIs, asymptomatic bacteraemia, and other infections of the urinary tract (Horan et al., 2008).

A study conducted by Miller et al. (2006) compared the definitions employed by the NNIS to bronchoalveolar lavage (BAL) for the detection of ventilator associated pneumonia in trauma. The NNIS definitions rely on a combination of clinical and culture data and the BAL involves a bronchoscope passed through the mouth or nose into the lungs and fluid is squirted into a small part of the lung and collected for examination. The NNIS definitions used were in excellent agreement overall and are useful as an epidemiological benchmarking tool in trauma patients. However, the use of NNIS definitions for bedside decision marking was less accurate. Sensitivity refers to the proportion of patients who are actually infected that are detected as being infected (Buehler et al., 2004). Specificity is the proportion of patients who actually do not have an infection that are detected as not having an infection (Klompas et al., 2009). In the study conducted by Miller et al. (2006) the sensitivity (84%) and positive predictive value (83%) were reasonably good, whereas the specificity and negative predictive value were low (69% and 69% respectively). The NNIS criteria would have resulted in 16% of patients not being treated that were diagnosed by BAL. Therefore the NNIS definitions had less utility as a bedside decision-marking tool in trauma patients leading to under treatments in a number of patients. For diagnoses of VAP, the BAL criteria are better suited and for benchmarking purposes NNIS definitions are useful. Many hospitals used NNIS definitions for benchmarking.

3.4.5 Methods for the collection and analysis of HAI surveillance data
There are several different HAI surveillance methods that can be used exclusively or in combination. The method selected is dependent on the specific HAI surveillance objectives with consideration of the time-effectiveness of the method, the accuracy of data, and the cooperation with hospital personnel e.g.- clinical ward staff, laboratory staff and infection control members. It should be established before the selection of HAI surveillance method
what the patients and unit are to be monitored i.e.- defining the population, the types of infections and relevant information to be collected for each case with the use of clear consistent definitions, and the frequency and duration of monitoring. Subsequently, the methods for data collection, data analysis, feedback, and dissemination should be selected (WHO, 2002).

Table 4 provides a detailed description of HAI surveillance methods along with the advantages and disadvantages of each approach. The table draws on information from Pottinger et al. (1997), Gastmeier et al. (2000), WHO (2002) and the CDC’s Outline for HAIs Surveillance (2006). HAI surveillance methods include active, passive, retrospective, prospective, hospital-wide, comprehensive, targeted, on-going, periodic and outbreak threshold surveillance. Once a method has been selected for the monitoring of a HAI, it is important that the same definitions and data collection method is used over time so that any observed changes in HAI rates are not due to methodology changes.

The concept of targeted surveillance was refined after results from the SENIC study showed that different control activities were effective at preventing infections at different sites. The type of targeted surveillance method was called ‘surveillance by objective’, which provided infection control personnel with a method for data collection of HAIs focusing on specific sites e.g.- SSIs, or HAIs within specific units e.g.-ICU (Haley, 1985a). Targeted surveillance can be limited to using microbiology laboratory data, incorporating laboratory-based surveillance methods whereby detection is based solely on the findings of laboratory studies of clinical specimens (Centers for Disease Control and Prevention, 2006).

Continuous on-going surveillance is part of routine auditing of HAIs which identifies incident cases or new infections. It is typically undertaken prospectively and is a strong method to establish trends and distribution of infection. Continuous surveillance can be active, passive or a combination of both. Alternatively, point prevalence surveys can be conducted if limited resources are available. Prevalence rates would differ from those produced by continuous surveillance, prevalence surveys involve the collection of data on existing HAIs and new cases of HAIs that occur during the surveillance period. This method can be used to focus on areas or services where HAIs are suspected to be high, displaying the magnitude of HAIs
within the facility or region and highlighting problems requiring more investigation. Prevalence surveys may also be used when HAIs are rare; if information from the laboratory suggests low HAI rates then a point prevalence survey on processes may be appropriate. Point prevalence surveys can be performed at various intervals, usually a week or a month. Incidence rates can be calculated from prevalence data, but only when large patient groups have been studied (McLaws, 2011). Prevalence rates are influenced by duration of the patient’s stay, as infected patients stay longer, resulting to an overestimation of patient’s risk of acquiring an infection.

It is recommended by WHO (2002) that some form of active surveillance involving prevalence or incidence studies is performed; as passive surveillance performed by hospital personnel outside of the infection prevention control team or laboratory is of low sensitivity.

Information regarding intrinsic and extrinsic risk factors should be collected to ensure rates of HAIs have not changed because of these factors rather than clinical practice (McLaws and Taylor, 2003). Intrinsic risk factors are those that are inherent in the patient, including age, gender, blood loss, smoking behaviour, immune status, or underlying conditions that may increase the patient’s risk of infection. Extrinsic risk factors reside in the patient care staff or the institution and include factors such as poor hand hygiene by healthcare workers, pre-operative length of stay, duration of surgical procedures, and pre-operative skin preparation. Extrinsic factors can be easier to control, but both factors can change HAI rates (Bereket et al., 2012).

The value of active compared with passive surveillance techniques and prospective over retrospective methods should be considered. The CDC recommends that routine HAI surveillance in healthcare facilities should be conducted by an infection control professional (ICP) in an active, patient-based, prospective, priority-directed manner that yields risk-adjusted incidence rates. This methodology is most useful for the detection of endemic HAIs with the NHSN modules incorporating these methods.
<table>
<thead>
<tr>
<th>Surveillance Method</th>
<th>Description</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Surveillance (Centers for Disease Control and Prevention, 2006).</td>
<td>Surveillance is performed by trained infection control personnel.</td>
<td>Because of the more objective approach of the infection control personnel, and their education in hospital epidemiology, better surveillance quality can be expected.</td>
<td>Requires qualified infection control personnel which is expensive.</td>
</tr>
<tr>
<td>Passive Surveillance (Centers for Disease Control and Prevention, 2006).</td>
<td>Surveillance is performed by direct patient care staff.</td>
<td>This allows consideration of information not documented in the patient’s chart during case identification.</td>
<td>Surveillance is an additional task among other priorities for direct patient care staff, and cases are usually under-reported. Inconsistent use or non-use of standard case definitions. Low sensitivity.</td>
</tr>
<tr>
<td>Prospective Surveillance (Centers for Disease Control and Prevention, 2006).</td>
<td>Beginning from a starting point, patients are monitored by repeated observation for the development of HAI.</td>
<td>Uses all available resources of information for identifying HAIs. Further investigations can be performed and interventions initiated if necessary.</td>
<td>Requires substantial time and effort because the patients have to be evaluated repeatedly.</td>
</tr>
<tr>
<td>Retrospective Surveillance (Centers for Disease Control and Prevention, 2006).</td>
<td>All newly occurring HAIs are recorded for a specific observation period taking place sometime in the past, including risk factors.</td>
<td>Each patient chart has to be investigated only once. Very useful in outbreak situations.</td>
<td>The quality of the survey depends on the quality of clinical documentation. Data may lack utility and timeliness if it occurred too far in the past.</td>
</tr>
<tr>
<td>Targeted Surveillance (WHO, 2002).</td>
<td>Surveillance can be oriented to target certain sites, units or priorities. Site-oriented surveillance can monitor frequent HAIs with significant impact in mortality, morbidity, and cost E.g.- VAP. Unit-oriented surveillance can monitor high risk units or area E.g.- ICU Priority oriented surveillance can be performed to monitor a specific issue of concern to the facility E.g.- UTI in patients with urinary catheters in long-term facilities.</td>
<td>Concentrates limited resources on high risk areas. Focuses on infection with known control measures to reduce infection risk. Can determine valid denominator. Flexible, can be mixed with other strategies. Targeted surveillance limits the scope of surveillance so that infection prevention personnel can assess accurately the risk of infections in the surveyed populations. Therefore, staff can assess accurately the risk of infections in the surveyed populations.</td>
<td>Collects data only for targeted patients or risks. May miss clusters or outbreaks in non-surveyed populations. Targeted programmes can be limited to only using microbiology laboratory data.</td>
</tr>
<tr>
<td>Method</td>
<td>Description</td>
<td>Benefits</td>
<td>Drawbacks</td>
</tr>
<tr>
<td>---------------------------------------------</td>
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</tr>
<tr>
<td>Hospital-wide, Traditional Surveillance</td>
<td>Comprehensive, IPC prospectively and continuously survey all care areas to identify HAIs. Data is gathered from daily lab reports and from medical records of patients receiving antibiotics or on isolation precautions. Information is also obtained by frequent discussions with nurses and occasionally seeing patients. ICP also periodically reviews all autopsy and employee health records.</td>
<td>Collects comprehensive data on all infections in the facility. Establishes baseline infection rates. Identifies patterns of infections. Recognises outbreaks early. Increases visibility of ICP.</td>
<td>Expensive, labour intensive, and time consuming. Yields excessive data. Leaves little time to analyse data and initiate changes. Detects infections that cannot be prevented. Does not allow for internal comparison.</td>
</tr>
<tr>
<td>Incidence surveys or continuous surveillance</td>
<td>On-going monitoring on a specific ward over specified time period. Patients are followed throughout their stay and sometimes after discharge.</td>
<td>Provides a complete picture of the situation, stability of infections rates is likely to be achieved over time, and trends can be analysed.</td>
<td>Requires substantial time, labour intensive and costly.</td>
</tr>
<tr>
<td>Prevalence Surveys</td>
<td>Monitoring of patients at a given point in time either throughout the whole hospital or in selected areas.</td>
<td>Simple, fast and relatively in-expensive.</td>
<td>Can overestimate the patient’s risk of acquiring an infection as prevalence rates are influenced by the duration of the patient’s stay.</td>
</tr>
<tr>
<td>Periodic Surveillance or Time-limited (rotating)</td>
<td>Involves rotating surveillance periods on specific care areas. There are several approaches: 1. Conduct hospital-wide surveillance during specific time interval i.e.- one month each quarter. Hospitals that use this method frequently conduct targeted surveillance during the alternate periods. 2. Conduct surveillance on one/ few units for a specified time period and then shift to another unit/s. By rotating surveillance from unit/s to unit/s, the ICP is able to survey the entire hospital during the year.</td>
<td>Allows comprehensive surveillance activities even when limited infection control personnel are available. Increased efficiency of surveillance. Liberates ICP team to perform other activities.</td>
<td>Random effects due to short surveillance periods may lead to mistaken conclusions and infection control problem in other areas. Provides data only during periods in which surveillance is conducted. May miss clusters or outbreaks during non-surveilled periods.</td>
</tr>
<tr>
<td>Outbreak Thresholds</td>
<td>Routine surveillance is stopped and problems are only evaluated when the number of isolates of a particular species or number of positive cultures exceeded outbreak thresholds.</td>
<td>Automatic, on-going monitoring. Thresholds are institution specific. Investigation is prompted by objective threshold.</td>
<td>Does not provide data on endemic rates. Difficult to compare rates with outside institutions. Could still have problems that are just below threshold citing.</td>
</tr>
<tr>
<td>Patient-based Surveillance</td>
<td>Count HAIs, assess risk factors, and monitor patient care procedures and practices for adherence to infection control principles.</td>
<td>Risk factors are investigated.</td>
<td>Requires ward rounds and discussion with caregivers.</td>
</tr>
</tbody>
</table>
## Table 5. Description of Measures of HAI Frequency

<table>
<thead>
<tr>
<th>Measures of frequency for HAI</th>
<th>Description</th>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>Incidence</td>
<td>Incidence rate= Number of new HAI occurring during a given period divided / by the number of patients at risk of acquiring HAI during the period. E.g.-Nosocomial MRSA cases per 100 patients admitted.</td>
<td>Provides a complete overview of the period from admission to discharge. Allows risk factor analysis.</td>
<td>Requires substantial time and effort of trained personnel.</td>
</tr>
<tr>
<td>Risk-adjusted incidence rates</td>
<td>Rates of HAIs are controlled for variations in the distribution of major risk factors associated with an event’s occurrence.</td>
<td>Such rates allow inter- and intra-facility rate comparisons.</td>
<td>Requires additional analyses and data and is more complex.</td>
</tr>
<tr>
<td>Crude incidence rates</td>
<td>Rates assume equal distribution of risk factors for all events.</td>
<td>Relatively quick and less data is required.</td>
<td>Such rates cannot be used for inter- and intra-facility rate comparisons.</td>
</tr>
<tr>
<td>Prevalence</td>
<td>Prevalence surveillance involves counting the number of active infections during a specified time period- active infections are defined as all infections that are present during the time of the survey, including those that are newly diagnosed and those that are being treated when the survey begins. Because new and existing infections are counted the values obtained from prevalence surveys are usually higher than incidence rates. Prevalence rate=number of all currently active cases of disease within a specific population at risk during a specific period of time divided by the number of patients at risk during this period. E.g.- Prevalence of urinary tract infections in a given hospital on 1st of May.</td>
<td>Can monitor particular patients E.g.-those on venous catheters. Can determine the number of patients colonised or infected with important organisms E.g.-MRSA, VRE. ICP can be used to assess risk factors for infection in a particular population. Infection control staff could collect additional data about potential risk factors from all patients surveyed and determine why patients in this population are developing infections. Identifies areas that need additional surveillance. Assess all patients in the target population, regardless of whether they have infections. ICP can compare the rate of infection in patients who have the risk factor with the rate in those who don’t have the risk factor- identifies risk factors. Relatively quick and inexpensive.</td>
<td>Must collect data in short time period. Data are restricted to a specific time period. Cannot compare prevalence rates with incidence rates. Few studies on prevalence rates published.</td>
</tr>
</tbody>
</table>
3.4.5.1 Post-discharge surveillance

Patients are often discharged before showing signs of infection; the inclusion of post-discharge SSI surveillance would increase infection rates in participating hospitals and would provide a complete picture of infections occurring in hospitals. However, Roberts et al. (1998) argues that post-discharge surveillance detects mostly superficial nosocomial infections which are seldom associated with significant complications and recommends that limited hospital resources should be prioritised for the identification of HAIs that may result in morbidity and mortality. These types of infections would generally be those detected during hospitalisation and those that result in readmission (Roberts et al., 1998).

A post-discharge surveillance study investigated the benefits of using an extended regimen for SSI surveillance. A total of 756 orthopaedic patients from two centres who received artificial joint replacement of the hip or knee were investigated. The extended regimen for SSI surveillance system included sending a questionnaire to patients 12 months post-discharge. The extended regimen was compared to established SSI surveillance programme which involved an integrated system with the surgical wards and outpatient clinics. All complaints were followed up by contacting the patient and any clinicians and general practitioners involved. SSIs were detected in 3.15% of patients after artificial joint replacement of hip; a quarter of these infections were detected after discharge. However, the SSIs were reported using the extended regimen and also the current established SSI surveillance system, suggesting that the extended regimen for surveillance was not needed (Huenger et al., 2005).

Avato and Lai (2002) identified that infection prevention and control personnel spend a considerable amount of time collecting and analysing data including post-discharge infections and that such expenditure of time and money may not be justified for one surgical procedure. A system that quickly detects significant changes in rates of infection through simple indicators that can be easily monitored, such as hospital readmissions and procedures performed due to infections may be an alternative and less resource extensive method for monitoring HAIs. This approach would still require the allocation of limited resources to a few procedures at one time subsequently identifying procedures linked with a higher risk of infection (Avato and Lai, 2002).
3.4.5.2 Data sources for HAI surveillance

Information concerning the presence of a HAI can come from a few sources. Laboratory reports and other diagnostic tests such as radiology and imaging information can be used to detect the presence of infection. Microbiology reports provide information on the potential infection and antimicrobial resistance patterns. Laboratory reports have a low sensitivity as cultures are not obtained for all infections, some pathogens may be not be isolated i.e.-viruses, furthermore the isolation of a pathogen may not represent infection but rather colonisation, this can be especially true for SSIs. However, some definitions of HAIs rely heavily on microbiological reports, improving the reliability of reports. Such infections include UTIs, BSIs and MDROs (WHO, 2002).

The trained infection control personnel can look for signs of infection through ward activity, such as antimicrobial therapy, record of fever or other clinical signs of infection, or the presence of devices or procedures known to be a risk for infection i.e.-indwelling catheters, mechanical ventilation, and surgical procedures. Data quality is further improved by continual collaboration between infection control personnel, laboratory members, and clinical staff as the exchange of HAI data can be readily communicated (Emori and Gaynes, 1993).

3.4.6 Statistics and analysis of HAI surveillance data

Data can be analysed by calculating either incidence rates including crude rates and risk-adjusted rates, or the prevalence of HAIs. Table 5 describes the different measures of HAI frequencies and their strengths and weaknesses. Case finding methods can include laboratory results, patient chart reviews, visiting clinical wards, post-discharge surveillance and investigating patients that have undergone specific treatments or procedures.

The numerator value is the number of people with the HAI and the denominator is the number of people at risk of developing the HAI. Rates of infection are calculated by the numerator divided by the denominator. A prevalence measure of HAI is the number of cases of active HAI in defined patient population during the point prevalence survey. It includes new and existing cases of HAIs. The incidence measure is the number of new cases of HAIs occurring in the defined patient population during the surveillance period. Continuous
surveillance measures the cumulative incidence of cases in the population at-risk. To establish data that reflects the survey period, prevalence data collected using point prevalence survey should be immediately analysed at the end of the survey period. Incidence data are usually analysed periodically to establish rates at specific time periods, these rates are usually calculated at the end of each month or quarter (McLaws, 2011). Incidence rates take into account the length of exposure, or the length of stay and/or follow of the patient; providing a good representation of the HAI risk and facilitates comparisons, either device-associated rate or patient-day rates can be used (WHO, 2002).

HAI surveillance data analysis includes the description of the population frequency of risk exposure and infections, calculation of rates, comparisons of patient groups, and comparisons of rates over time. Risk factor information allows for stratification of patients risk and allows for the calculation of risk adjusted rates for accurate comparisons. Adjusted rates allow for unit comparisons over time with trends detected and similar units, population groups or hospitals can be compared. Benchmarking HAI rates is later discussed (WHO, 2002).

### 3.4.7 Information dissemination of HAI data

The dissemination of collected and analysed HAI data to relevant personnel in a timely manner to those who need to know so that action can be taken is critical to the success of a surveillance programme. Surveillance results must be provided regularly and in a timely manner to clinical staff in order to help them choose actions to reduce infection rates. For maximum effect the dissemination of HAI surveillance information should be prompt, relevant to the target groups, and directed to those who have the potential to influence infection control and prevention activities (WHO, 2002). The dissemination of data to health care providers, along with standardised definitions and protocols and risk adjusted infection rates are key elements of surveillance systems which are successful in preventing infections (Gaynes et al. 2001).

A system of continuous monitoring and on-going feedback of SSI rates in a timely manner to clinicians in an Australian hospital was able to decrease overall SSI rates by approximately
These results are similar to the findings of the SENIC project (Haley, 1985b). According to McLaws (2011) surveillance reports to clinicians should include: the surveillance reporting period, whether the data are prevalence or incidence measures, rationale for surveillance being focused on particular at risk-patients, rates calculated separately for specific HAIs, threshold rate and source of the threshold and control, and prevention action required. Descriptive information concerning numerator and denominator data for each rate calculated should be provided to clinical staff. Surveillance information from the previous period should be retained in order to identify trends and detect any statistically significant changes (McLaws, 2011). The reports should also ensure anonymity of both individual patients and responsible physicians (WHO, 2002).

Possible options for reporting information include: meetings where information is reported and discussed, summaries of information can be presented in graphic presentations on notice boards within the unit, surveillance information could also be disseminated to hospital units by the hospital infection control committee, hospital management or microbiology laboratory. When reporting information to relevant personnel it is important that issues concerning confidentiality, comparability, representativeness, risk-adjustment rates, and sample sizes should be evaluated (WHO, 2002).

### 3.4.7.1 Benchmarking HAI surveillance data

The NNIS definitions allow for benchmarking and hospital comparisons. Benchmarking allows for the accurate measurement of a process, the identification of best practice, and direction on how one organisation can improve performance based on a superior performer. It is critical that the event of concern is carefully defined by a consistent, reproducible set of identifiers (Jarvis, 2007, Kiefe et al., 2001). Internal and external benchmarking aims to improve healthcare delivery by identifying strengths and weaknesses, stimulating competitiveness, and assessing the value of interventions intended to reduce HAIs (Yokoe et al., 2008). However, both internal and external benchmarking processes have limitations. Internal benchmarking within a healthcare facility compares processes or outcomes to baseline data or comparisons between different hospital departments. This process can be
useful and is a feasible approach. The drawback of internal benchmarking involves the collection of baseline data that is of adequate size for statistical comparison, requiring significant time and resources. Furthermore, there is no ability to adjust for changes over time, i.e.- patient, healthcare and methodological changes. External benchmarking involves comparing processes and outcomes between healthcare facilities performing similar activities. The limitations with external benchmarking is accounting for differences in patient risks and surveillance methodologies (Lenz et al., 1994). The literature emphasises that benchmarking should facilitate analyses and promotion of best practice using standardised cases definitions, similar data collection methods along with adequate population sizes, over a sufficient duration of time as results are required to be statistically significant to allow for comparisons (Ettorchi-Tardy et al., 2012).

Risk stratification and risk adjusted rates, or ratios, allow fair comparisons (Kanerva et al., 2010). Stratification is a common adjustment method used in benchmarking reports, as risk adjustment accounts for differences in patient case mix allowing for more meaningful comparisons between surgeons or between hospitals, especially when using summary data as a quality improvement performance indicator (Anderson et al., 2010). The NHSN reports on type-specific rates of device associated HAIs which are stratified by procedure specific SSIs and critical care unit types i.e.- adult and paediatric and neonatal units (Mu et al., 2011, Klevens et al., 2007b).

3.4.8 Computer databases for HAI surveillance

The notion of using technology in infection control programmes began over 20 years ago with the development of computer programmes to enhance the detection and continuous monitoring of HAIs (Evans et al., 1986). Specific surveillance computer programmes have been developed and are now utilised in many resource-equipped countries. These software programmes have a range of benefits for HAI surveillance. Computer programmes save time by cross-linking data across medical information systems, minimising data entry task and errors, and generating automatic reports (Cauet et al., 1999). Recent literature concerning HAIs has a focus on the automation of HAI surveillance. This section discusses the evidence
supporting the use of computer systems and identifies the different types of computer systems used in hospitals for HAI surveillance.

One of the earliest computer database systems developed for HAI surveillance was the Interactive Data Entry and Analysis System (IDEAS). The programme was produced in 1984 by the CDC as part of the NNIS system. The software package allow for infection and denominator data to be entered through formatted screens providing a flexible data analysis system for the production of reports, the creation of graphics and the transmission of data to the CDC (Emori et al., 1991b). A systematic review was conducted by Leal and Laupland (2008) to compare the utility of electronic and conventional surveillance methods. The study found that electronic surveillance that utilises information held in databases is more efficient than conventional infection surveillance methods. Automated or electronic surveillance of infectious diseases was defined as the process of obtaining information from inter-related electronic databases for identifying infection distribution within a particular setting (Leal and Laupland, 2008).

Electronic systems involves data being utilised from existing databases after being collected for other laboratory, administrative, or patient care purposes. Therefore, the benefits of using it are that it is potentially inexpensive and efficient to obtain. Automated programmes were found to reduce surveillance time by up to 61%, which potentially reduces the costs and can free up human resources from routine surveillance for proactive preventive efforts or outbreak investigation (Chalfine et al., 2006, Brossette et al., 2006). Once the electronic system is implemented, the size and comprehensiveness of surveillance is potentially independent of cost. Once the programme is installed and staff members using the system are educated, minimal finance is required. HAI surveillance using electronic systems can be implemented for more than just selected infections, previous systems have been restricted to important infections such as bloodstream or ventilator-associated pneumonia (Brossette et al., 2006). When an infection of interest is defined by the presence of a positive culture, electronic surveillance should have 100% sensitivity and may be expected to be higher than for conventional surveillance where errors may occur, especially where paper-based or passive reporting is used (Wright et al., 2004). Some of the limitations of electronic surveillance include the system being insensitive to infections that may be diagnosed based on clinical evaluation of symptoms or tests other than a positive culture-based test e.g.-
toxic shock syndrome (Wurtz and Cameron, 2005). This limitation would occur for any system that relies explicitly on laboratory notification. Furthermore, positive cultures may not represent infection, i.e. common skin contaminants in blood culture or with cultures from non-sterile body sites for example wounds, urine, and respiratory tract. Electronic surveillance systems utilising laboratory cultures alone may potentially classify these as an infections and clinical judgement is often required to exclude them (Leal et al., 2010).

Claridge et al. (2009) developed the Surgical Intensive Care-Infection Registry (SIC-IR). The database was designed with the contribution of clinical staff, surgeons, pharmacists, and computer scientists and involves the collection of more than 100 clinical variables on each surgical and trauma intensive care unit (STICU) patient. The system assists in caring for critically ill patients and creates an electronic medical record for all STICU patients. The SIC-IR is integrated with the hospital’s laboratory information system as well as the medication administration record for automatic data loading to ensure registry consistency and accuracy. Variables include information associated with infection complications e.g.- demographics (age, sex, ethnicity), vital statistics, laboratory values, current antibiotic treatment, prior and current infections complication, co-morbidities, the impact of time and interventions. Data regarding indwelling urinary catheters, central venous access devices, ventilator requirements, use of steroids and blood product transfusion is also collected through the system. SIC-IR was compared to the standard surveillance involving a combination of prospective and retrospective analysis by trained infection control teams. The sensitivity and specificity values for detection of ventilator-associated pneumonia were calculated. Of the 40 patients confirmed with ventilator associated pneumonia (VAP), SIC-IR detected 39 of the cases while standard monitoring involving a combination of prospective and retrospective analysis by trained infection control teams recognised 22 of the VAP cases. This gives the infection control method a sensitivity of 56% and specificity of 99% for identifying VAP and the SIC-IR method has a sensitivity and specificity of 97% and 100% respectively (Claridge et al., 2009). It is concluded from these results and from other studies, that the surveillance of HAI can be improved by utilising a computerised registry in real time to track all patients prospectively (Evans et al., 2009, Garcia Álvarez et al., 2011, Koller et al., 2010, Tinoco et al., 2011).
3.4.9 Literature review objective one summary
As illustrated in this section there are key concepts to consider when developing and utilising a HAI surveillance system. The fundamentals of HAI surveillance systems involve determining clear objectives for HAI surveillance, with the methods selected dependent on the resources available and the surveillance objectives. Case definitions should be used consistently throughout the healthcare facility. The feedback of information in a timely manner to those who need to know so that action can be taken is critical to the success of a surveillance programme. The utilisation of computer databases and software programmes are an effective method for improving accuracy and reducing resources and the time required to conduct adequate surveillance. The healthcare facility performing HAI surveillance should develop a clear surveillance plan outlining the objectives, definitions, types of infections monitored, methods used and frequency of data collection and dissemination; this would create a systematic and explicit approach to HAI surveillance.

3.5 Literature review objective two
This section reviews the HAI surveillance systems used in developed countries with the aim of identifying best practice.

3.5.1 The NNIS and NHSN systems
The NNIS system was an on-going, voluntary, collaborative approach to nosocomial infection surveillance, involving data collection, descriptive epidemiology, and analysis of nosocomial infection rates (Emori et al., 1991b). Since the 1990s, many developed countries established regional or national systems for the monitoring of HAI, many of which have adapted or adopted components of the NNIS system or the reformed National Healthcare Safety Network (NHSN). This section provides a detailed description of NNIS/ NHSN systems. The section outlines the core objectives, components and methods of the systems.

During 1990-1999, risk-adjusted infection rates decreased for respiratory tract, urinary tract, and bloodstream infections in ICU. Hospitals participating in the NNIS during this time frame showed substantial decreases in BSIs in medical (non-surgical) ICUs (44%), surgical ICUs (31%), and paediatric ICUs (32%) (Centers for Disease Control and Prevention, 2000). The
critical elements of the NNIS system contributing to successful reductions in HAI rates include: voluntary participation and confidentiality, standardised definitions and protocols, identified populations at high risk (intensive care, surgical patients), site-specific surveillance, risk adjusted infection rates which are comparable across institutions, adequate numbers of trained infection control practitioners, the dissemination of data to health-care provider, and links between monitored rates and prevention efforts allowing hospital personnel to alter their behaviour based on data obtained (Gaynes, et al 2001).

The NNIS system involved a hospital-based reporting system established to monitor HAI and to direct infection prevention and control activities. Detailed information on each infected patient such as demographic characteristics, infections and related risk factors, pathogens, and antimicrobial susceptibilities, and outcomes are recommended to be collected by a trained infection control professional (Emori et al., 1991a).

The National Healthcare Safety Network (NHSN) was established in 2004 to incorporate three separate CDC surveillance systems: the NNIS system, the Dialysis Surveillance Network, and the National Surveillance System for Healthcare Workers (Sprague, 2009). The NHSN began with 300 hospital and now has over 11,500 health care facilities contributing data, allowing for facilities, regions, and the country to identify HAI problems areas and measure progress and prevention efforts (Centers for Disease Control and Prevention, 2013b). The system involves a secure, internet-based surveillance programme, allowing entry of events and denominator data for both device-associated and procedure-associated events as well as data entry for microbial susceptibility and antimicrobial use (Dudeck et al., 2011). The system provides standardised and validated methodology and data collection protocols with standardised definitions of HAI. Data collected from participating hospitals allow for the generation of annual reports establishing national risk-adjusted benchmarks and reports on site-specific infection rates (Horan et al., 2008).

3.5.1.1 Objectives of the NNIS and NHSN systems
The NNIS surveillance objectives documented by Emori et al. (1991b) have the following aims:
• To estimate the incidence of nosocomial infections in the United States; to identify trends in infection rates, sites, risk factors, patient outcomes, nosocomial pathogens, and antimicrobial resistance;
• To provide hospitals with comparative data on nosocomial infections that they can use to evaluate their prevention and control efforts;
• To develop efficient and effective data collection and analysis methods for nosocomial infection control; and to conduct collaborative research studies;
• To describe the epidemiology of emerging infections and pathogens, and to characterise mechanisms of antimicrobial resistance in nosocomial pathogens.

Pottinger et al. (1997) and Gaynes et al. (2001) have shown that these objectives have stayed similar since their introduction in the early seventies.

The NHSN surveillance system objectives of 2010 have been summarised to include the following purposes:
• To collect data from a sample of health care facilities in the United States to permit valid estimation of the magnitude of adverse events among patients and health care personnel
• To collect data from a sample of health care facilities in the United States to permit valid estimation of the adherence to practices known to be associated with prevention of these adverse events
• To analyse and report collected data to permit recognition of trends
• To provide facilities with risk-adjusted metrics that can be used for interfaculty comparisons and local quality improvement activities
• To assist facilities in developing surveillance and analysis methods that permit timely recognition of patient and healthcare worker safety problems and prompt intervention with appropriate measures
• To conduct collaborative research studies with NHSN member facilities e.g., describe the epidemiology of emerging HAIs and pathogens, assess the importance of potential risk factors, and evaluate alternative surveillance and prevention strategies (Dudeck et al., 2011).
The objectives of the NHSN system are the following: to estimate the magnitude of HAIs and to discover trends in HAIs, to facilitate internal and external hospital comparisons with risk-adjusted data that can be used for local quality improvement activities, to assist facilities in developing surveillance and analysis methods that permits timely recognition of patient safety problems and prompt intervention with appropriate measures. The NNIS/NHSN systems are designed to minimise the burden of data collection and reporting by hospitals. The reliability of data depends on the assumption that infection control personnel performing surveillance are using standardised definitions and data collection protocols (Edwards et al., 2009).

3.5.2 Components of the NNIS system
Acute care hospitals with more than 100 beds were allowed enrolment entry into the NNIS system. The NNIS system initially included the single method of hospital wide, comprehensive surveillance. In 1986 three additional surveillance components were added to the hospital component of the NNIS system, allowing for the calculation of risk adjusted rates on specific groups of patients. The three components included surveillance of patient in ICU, high risk nursery (HRN), and in surgical areas (Sartor et al., 1995). Hospitals participating in the NNIS subsequently had the flexibility of performing surveillance that is appropriate in their hospital as surveillance components may be used separately or simultaneously for a calendar month.

3.5.3 Components of the NHSN system
The NHSN data collection, reporting, and analysis are organised into four programmes: Patient Safety, Healthcare Personnel Safety, Biovigilance, and Long-term Care Facility. The patient and healthcare personnel safety surveillance systems are managed by the Division of Healthcare Quality Promotion at the Centers for Disease and Prevention. The Patient Safety Component is the most analogous to the NNIS, it includes five modules: the device-associated module- for infections associated with invasive devices, the procedure-associated module- for post-procedure infections, the medication-associated module- for antimicrobial use and susceptibility, the multi-resistant organism (MDROs) and C. difficile module, and the vaccination module. Previously with the NNIS system there were specific enrolment requirements. However the NHSN does not have any enrolment requirements, with acute
care hospitals and chronic dialysis centres able to participate. Standardised methods and definitions are used within each specific module and in accordance with specific module protocols (Edwards et al., 2009). One of the biggest changes from the NNIS to the NHSN system is the shift from surveillance of all HAIs to only performing surveillance associated with invasive devices or procedures e.g.- SSI or post procedure pneumonia (Tokars et al., 2004). CDC definitions are used that involve laboratory and clinical criteria. The module can be used separately or in combination with other modules. Comparable to the NNIS system, facilities are able to choose which events to monitor. However, the data must be collected for a minimum of one calendar month before any changes regarding the monitoring of HAI events are made. (Centers for Disease Control and Prevention, 2009).

Individual participating hospitals can enter data locally onto the NHSN internet-based surveillance system and data is then centrally analysed. The NHSN system automatically calculates the risk-adjusted rate of nosocomial infections, allowing for inter-hospital comparisons and accounts for the possibility of nosocomial rates varying between hospitals due to differences in methods used. Furthermore, the NHSN system provides online prevention tools, involving guidelines and workbooks and generates automatic email notifications for selected adverse events to participating hospitals (Edwards et al., 2009). Modules concerning HAI surveillance data collection: device-associated module, procedure-associated module and MDRO/C. difficile module are outlined below.

Device-associated module

In the device-associated module the infection prevention hospital personnel can chose to collect data on CLAB, VAP, and cUTIs, that occur in patients staying in patient care areas, including ICU, wards, or critical care units. Data concerning central line insertion practices adherence and dialysis events can also be collected through this module. These areas are further characterised in the NHSN to patient population groups: adults, children, or infants. Denominator data concerning device-associated infections should be collected at the same time each day either from manually collected counts or electronic databases e.g.- ventilator days from respiratory therapy. If databases are used the counts of patients should not be substantially different (+/- 5%) from manually collected counts and validated for a minimum of three months (Centers for Disease Control and Prevention, 2013c).
The high risk nursery component of the NNIS system monitored on all nosocomial infections in selected units. However, with the corresponding modules in NHSN only device-associated infections selected by the infection control personnel are monitored (Tokars et al., 2004). Data collection from neonatal intensive care units (NICU) are categorised into 5 birth-weight group: less than or equal to 750g, 751-1000g, 1001-1500g, 1501-2500g and more than 2500g. The infection prevention and control personnel can collect data on CLAB, umbilical catheter-associated primary bloodstream infections, or VAP for each of the weight categories. All hospital areas can gather data on device associated infections. Adult medical/surgical ICUs are categorised into unit bed size: less than or equal to 15 beds, and greater than 15 beds. In hospital areas excluding NICU, the device days consisted of the total number of central line-days, urinary catheter days, or ventilator-days (Dudeck et al., 2011). Participating organisations are recommended to use data collection forms for HAI information gathering.

**Procedure-associated module**

The procedure-associated module allows the IPC personnel performing HAI surveillance to select the type of operative procedures to monitor from the NHSN category list concerning SSIs and post-procedure pneumonia. During the month chosen for surveillance, data is collected on every patient undergoing the selected procedures from the category list; data includes information on risk factors for SSIs such as duration of procedure in minutes, wound class, and the patients’ health. Patients undergoing certain procedures are monitored for the development of a SSI or post-procedure pneumonia or both. Denominator data from the specific types of patient care areas and procedure-specific denominator data are collected. Susceptibility data for chosen organisms and/or antimicrobial data for selected agents can be reported in the Medication-Associated module (Centers for Disease Control and Prevention, 2009).

The NHSN provides post-discharge and ante-discharge surveillance methods for both in-patient and out-patient procedures. These methods include:

1. Direct examination of the patients’ wound during post-procedure consultation.

2. Review of the patient’s medical records.
3. Surveying the surgeon of patients who have undergone procedure by mail or telephone.
4. Surveying the patient by mail or telephone.

Any combination of methods is acceptable for use in the procedure-associated module. However, it is compulsory to use CDC criteria for SSIs (Centers for Disease Control and Prevention, 2013c).

**MDRO and C. difficile module**

MRDOs and *C. difficile* infection are monitored under the MDRO module of the Patient Safety Component. There are two reporting options for MDROs and *C. difficile* infections, one focuses on laboratory identification and the other on infection surveillance reporting. The Laboratory-Identified Event Reporting method allows laboratory testing data to be used without clinical evaluation of the patient, providing a less labour intensive approach to tracking MDROs and *C. difficile* infections. This form of monitoring infections has no clinical purpose for patient diagnosis and treatment. The clinical units would be notified of infection through standard laboratory procedures. The healthcare facility can select to perform surveillance facility wide, or on specific areas. Monitoring specific locations requires the collection of denominator data. The Infection Surveillance Reporting method requires trained IPC personnel to monitor patients during their stay in at least one patient care location during the surveillance period for an MDRO(s) or *C. difficile* infection using the CDC/NHSN HAI definitions. Both the Laboratory-Identified Event Reporting and Infection Surveillance Reporting methods allow the healthcare facility to choose to monitor one or more of the following MDROs: Methicillin-resistant *S. aureus* (MRSA), vancomycin-resistant *Enterococci* (VRE), carbapenem resistant *Klebsiella* species and *Escherichia coli*, and multidrug-resistant Acinetobacter species. Both the resistant and the susceptible phenotypes of *S. aureus* can be tracked to provide concurrent measures of the susceptible pathogens as a comparison to those of the resistant pathogens in a setting of active MRSA prevention efforts (Centers for Disease Control and Prevention, 2013a).
3.5.3.1 NNIS/NHSN system methods

The modules described above require an active, patient-based, prospective approach to the surveillance of events and the corresponding denominator data, with all data collected by a trained infection prevention control personnel. This involves the IPC personnel obtaining data during a patient’s stay by screening a variety of data sources including laboratory, pharmacy, pathology, radiology/imaging databases as well as patient admission/discharge/transfer records and patient charts, including history, physical exam notes, nurses/physician notes. The final determination of a HAI event should be made by the IPC personnel (Centers for Disease Control and Prevention, 2013c). The NHSN surveillance techniques outlined by CDC state that laboratory-based surveillance should not exclusively be used, unless the all possible criteria for identifying an infection are based solely on laboratory evidence e.g. the detection of an MDRO or C. difficile infection is based on laboratory identification. Retrospective chart reviews can only be used when the patients are discharged before all information can be gathered. Furthermore, it is outlined in the surveillance techniques that NHSN surveillance forms should be used to gather data on specific infection types and NHSN definitions are required. This would also minimise the data collection burden that may be experienced by the IPC personnel, other hospital personnel can be trained to collect denominator data (Centers for Disease Control and Prevention, 2013c).

3.5.3.2 Limitation of NHSN

The Health Policy Report on the reporting of adverse events discusses that case ascertainment through the NNIS system can be time-consuming and costly with definitions that are complex and difficult to apply. The system was regarded as focusing on surveillance but not for overall infection control. However, the report regarded the system as successful for providing timely feedback of useful information from experts, with hospitals able to share data in a non-punitive manner (Leape, 2002).

Weber et al (2012) evaluated the completeness of NHSN data to determine what fraction of all HAIs would be included in a data report produced by the NHSN. Many device associated infections are included in the NHSN report. However, HAIs that are not associated with a device including pneumonia not associated with mechanical ventilation, BSIs not linked to a central line, and UTIs connected to a urinary catheter are not reported to the NHSN system.
Additionally, various SSIs are not reported; plastic surgery, ear, nose, and throat, and burn surgery are not included in the surveillance report. This limits the completeness of the system. Although definitions are standardised, they are changed frequently especially for cUTIs, and neonatal CLABs which can make it difficult for healthcare facilities outside of the NHSN to interpret results for benchmarking if they do not incorporate definition changes in a timely manner (Weber et al., 2012).

The NHSN reports allow participating facilities to benchmark their HAI rates against a large number of US hospitals using standardised HAI definitions, data collection, and reporting methods from specific hospital units. Hospitals are able to compare their infection rates to other hospitals, assisting in the development of prevention activities for HAIs which occur more readily compared to other facilities. However, it is important to consider that not all HAIs are reported through the NHSN and definitions often change, interrupting the continuity of reference data, requiring facilities to keep up-to-date with guidelines and re-organise systems. The NHSN reports do not perform active surveillance for surgical site infection post discharge, which has shown to increase SSI rates. Furthermore, there is no validation of reported data and no true cohort, limiting comparability over time (Holtz and Wenzel, 1992, Anderson et al., 2010).

3.5.4 National HAI surveillance system in other developed countries
The NNIS/NHSN systems incorporate requirements for an efficient and effective HAI surveillance system. Therefore, many developed counties including Germany (Gastmeier et al., 2006), France (Astagneau, 2009), England (Cooke et al., 2000), and Australia (Morton et al., 2008) have adapted the CDCs NNIS/NHSN surveillance system to meet their own needs for HAI surveillance. An overview of international surveillance system is provided in the following section. The national surveillance system of Germany, France, England, and Australia are discussed in this section together with how they compare to the US national HAI surveillance system.

3.5.4.1 European Centre for Disease Prevention and Control
The European Centre for Disease Prevention and Control (ECDC) uses the Hospitals in Europe Link for Infection Control through Surveillance (HELICS) protocol for collaborating HAI
surveillance in the European Union (Suetens et al., 2007). The Commission of the European Communities funded HELICS in 1994 with the aim of providing standard methods for surveillance of HAIs in Europe and to create benchmarking for European hospitals concerning HAI rates and antimicrobial resistance (Coello et al., 2001). There are over 17 European countries taking part in the programme including Austria, Belgium, Italy, Spain, Hungry, Germany, and France. Individual data are entered in the standardised national networks and all networks are centrally analysed (Zarb et al., 2012). Analogous to the NHSN system, the data is electronically entered and the large data set allows stratification and adjustments; the NHSN risk-index category is used for SSI stratification. Unlike the NHSN which collects only unit based data for device associated infections in ICU, the ECDC system collects unit based (denominator data) and patient based data (risk factors) in patients who stayed three or more days in the ICU and provides some data adjusted for patient risk. Additionally, the ECDC reports are expressed per 1000 patient days, and Poisson regression is used to adjust for case-mix defined according to the risk-index category. The limitations of this programme concern the standardised definitions as not all definitions of HAIs are followed by all countries participating and the ECDC definitions are not popular outside of Europe. Further adding to the limitations are the frequent changes in the surveillance systems limiting the frequency of report. Data on device associated HAIs is only collected from intensive care units and only seven surgeries are covered in the SSI reports (Hansen et al., 2012). National surveillance systems have been developed independently in European and in other industrialised countries, as described in the following sections.

3.5.4.2 Germany’s HAI surveillance system

The German national nosocomial infection surveillance system (Krankenhaus Infections Surveillance System (KISS)) was established in 1997 in order to measure the reduction of HAIs through infection control activities. The core principals of the system have been adopted by the NNIS/NHSN system along with CDC definitions, but take into account the varying needs of hospitals in Germany (Schwab et al., 2012). Hospitals can select to participate in one or multiple components depending on the hospital’s needs. The seven components are: 1. Patients in ICU, 2. Post-operative patients, 3. Preterm infants in neonatal ICU, 4. Post-procedure bone marrow transplants, 5. Post-procedure ambulant care patients, 6. Patients with central vascular catheters, urinary tract catheters, or patients on mechanical
ventilation and not in ICU, and 7. MRSA surveillance. The components concentrate on high risk hospital areas, instead of trying to capture data for the entire hospital. Each component has a different surveillance method and an introductory course for KISS data collection methods and training diagnosis with fixed definitions is required for participation (National Reference Centre of Nosocomial Infections, 2013).

In 2008 a total of 519 hospitals provided annual data for one or several surveillance components. The data collected from KISS is used for quality management by individual hospitals and benchmarking between hospitals. It takes on average 2-3 weeks to complete surveillance on one of the modules, depending on the size of the unit (Gastmeier et al., 2008b).

The effectiveness of the nationwide HAI surveillance system was demonstrated in the study involving 150 ICUs and 133 surgical departments, producing significant reductions in ventilator-associated pneumonia (29%), central-venous-catheter-related primary bloodstream infections (20%) and surgical site infections (28%) over a 3 year period. The study demonstrated the beneficial effect associated from on-going surveillance activities and appropriate feedback to the users (Gastmeier et al., 2006). The KISS system’s success has been attributed to the close contact between the participating institutions, consideration of new developments, timely and regular data feedback, and constant re-evaluation of data presentation, data validity, and demonstration of its contribution to the reduction of HAIs (Gastmeier et al., 2008b).

3.5.4.3 France’s HAI surveillance system
The French HAI surveillance programmes were first developed at the regional level with five regional infection control coordinating centres developed in 1992. Five HAI modules were concerned with the following areas: SSIs, ICU, bloodstream and body fluids exposure, BSI, and multi-resistant bacteria. Healthcares facilities are able to participate in this programme on a voluntary basis (Astagneau and Brücker, 2001). Surveillance of SSIs and in ICU incorporates CDC definitions for HAI. They produce standardised indicators, such as SSI rates adjusted by the NNIS index, and pneumonia rates according to ventilator utilisation. The NNIS structure is not used for the collection of denominator data. A patient-based system is
used in France, where risk factors for each patient are documented not aggregated by unit. The National Surveillance System for Healthcare Workers was adopted for the surveillance and for blood and body fluid exposure. BSI and multi-resistant bacteria surveillance was laboratory-based. For each type of infection or unit under surveillance the data obtained is entered and analysed using specific software by the participating healthcare facility. Data is then validated and aggregated into a regional database for benchmarking purposes. Regional surveillance methods have been synchronised and data is logged into a national database. Many healthcare facilities throughout France participate in the surveillance programme. In 2003, 272 facilities performed SSI surveillance, 125 ICU, 263 for blood and body fluids exposure, 150 for BSI, and 549 for multi resistant bacteria. Annual national surveillance reports are available through the Nosocomial Infection Early Warning, Investigation and Surveillance Network - the government organisation coordinating the programme (Astagneau, 2009).

3.5.4.4 England’s HAI surveillance system
The national English programme called Nosocomial Infection National Surveillance Service (NINSS) was established in 1997 with voluntary participation into the programme (Wilson et al., 2002). By 2008, mandatory active surveillance for *C. difficile* infections, MRSA bacteraemia, Glycopeptide-Resistant *Enterococcal* Bacteraemia, and orthopaedic SSI had been implemented, along with the introduction of post-discharge surveillance and web-based data entry and reporting. At the end of each surveillance period, stakeholders from the participating hospital receive individual reports comparing their results to aggregated data from all participating hospitals. CDC definitions and the NNIS risk index are used in the national programme. Other HAI s are also monitored through a voluntary microbiology laboratory reporting system (Pearson, 2009, Goldenberg et al., 2012). The Health Protection Agency provide an integrated approach to protecting the United Kingdom’s public health, they provide a range of support and advice to the National Health Service including microbiology services. The agency has recently been incorporated as part of Public Health England who assists in infection control and the control of antimicrobial resistance in healthcare settings (Health Protection Agency, 2013).
3.5.4.5 Australia’s HAI surveillance system

The Australian Commission on Safety and Quality in Health Care (ACSQHC) under the 2011 Health Reform Act established a Clinical Care Standards Programme, the to ensure clinical care standards are appropriate and aims to reduce variation and improve clinical and patient experience (Australian Commission on Safety and Quality in Health Care, 2013). The programme incorporates 10 National Safety and Quality Health Service (NSQHS) Standards and an accreditation scheme for improving Australia’s health system by providing a nationally consistent statement about the level of care consumers can expect from health services. The third NSQHS standard is preventing and controlling healthcare associated infections and incorporates governance and systems for infection prevention, control, and surveillance. To support the national surveillance programme in Australia, three implementation guides have been developed by a technical advisory group in collaboration with clinical experts from different jurisdictions. The programme allows for standardised methods and definitions. The surveillance guides focus on *S. aureus* bacteraemia, *C. difficile* infection and CLAB infections and provide clear details for the implementation of surveillance including definitions, flowcharts, inclusions, and exclusions for each surveillance topic (Australian Commission on Safety and Quality in Health Care, 2012).

Prior to the development of the NSQHS standards, most jurisdictions in Australia used similar or identical definitions for SSIs and BSIs and mandatory surveillance participation was required in hospitals in New South Wales, but not in Queensland, South Australia, Tasmania, Victoria, or Western Australia (Cruickshank and Ferguson, 2008). There was no systematic Australia-wide approach to the measurement of patient harm caused by or associated by HAIs (Australian Commission on Safety and Quality in Health Care, 2012). The national surveillance initiative came after a 2008 report compiled by 51 infection experts across Australia, titled “Reducing harm to patients from healthcare associated infections: the role of surveillance”. The report provided a comprehensive description of the surveillance of HAIs in Australia and demonstrated the cost associated with HAIs on individual patients and the Australian healthcare system (Cruickshank and Ferguson, 2008).
3.5.5 Literature review objective two summary

The CDC’s NHSN systems incorporate requirements for an efficient and effective HAI surveillance system. The elements, HAI definitions, and methods for collection and analyses of data have been well documented and reviewed in many articles and reports. The key elements for a successful surveillance system have been recognised to be included in the NHSN. The NHSN involves an internet based national programme involving a device-associated module, procedure-associated module and a MDRO/C. difficile with data collected in an active, patient-based, prospective manner, and usually by an trained IPC member.

Many developed counties including Australia, England, Scotland, the Netherlands, Germany, and France have adapted the NNIS/NHSN system to meet their own needs for HAI surveillance, emphasising the international acceptance of the programme.

3.6 Literature review objective three:

This section reviews frameworks used to assess surveillance systems for HAIs and adopts a HAI surveillance framework for this thesis.

3.6.1 Frameworks for the evaluation of HAI surveillance systems

There are a range of methods that can be used for HAI surveillance. It is accepted by many researchers and investigators in this field that continued and on-going monitoring is advantageous. But the type of surveillance depends on resources available and specific events. It is necessary for infection control personnel in each hospital to become familiar with different methods, components, their strengths, and limitations in order to carry out surveillance that is specific to their hospital needs. A literature review was conducted to identify the different frameworks for evaluating HAI surveillance systems.

3.6.2 Evaluation of established surveillance system methods

The literature review found a range of articles that investigate and evaluate healthcare systems and methods employed in tertiary hospitals. This section identifies the findings of evaluation studies concerning HAIs.
The CDC’s guidelines for measuring surveillance, identifies measures of accuracy to determine the completeness and validity of the data recorded by surveillance systems. Sensitivity, specificity, and positive predictive values are key measures identified in the literature for evaluating surveillance methods.

Glenister et al. (1991) compared surveillance methods for their ability to detect HAIs. A reference method involving continuous clinical surveillance and the review of laboratory reports was compared to three approaches: 1. Ward liaison surveillance, involving discussions with nursing staff twice weekly to determine patients with infections. 2. Risk factor surveillance, involving the follow-up of patients with signs that indicated a risk of infection. 3. Laboratory-based ward liaison surveillance, involving the follow-up of microbiology reports by reviewing case records as well as discussions with nurses. After the 11-month study period, laboratory-based ward liaison surveillance was found to be the most effective surveillance method. This method detected 71% of the HAIs identified by the reference method and required 7.75 hours per week for data collection. Ward liaison surveillance identified 58% (requiring 4.3 hours per week) and the risk factor surveillance method identified 49% (requiring 7.9 hours per week) of the HAIs. The sensitivity and specificity values for the methods were calculated in two stages. Stage one concerned selecting patients for further follow-up based on clues, stage two involved the identification of patients with a HAI after follow-up by the review of case records. The stage one and two sensitivities of the laboratory based method were 98% and 76%, the specificities for the two stages were 91% and 100% (Glenister et al., 1991).

Two retrospective active surveillance methods and a prospective method were compared to a reference standard prospective surveillance method in a Spanish tertiary care hospital. One method involved the review of the medical records and the other reviewed discharge records. Sensitivity and specificity values were used as measures of accuracy. Retrospective surveillance was used to review 97.5% of the patients included in the study. The documented cumulative incidence of nosocomial infections was 21.8% for the prospective, 19.6% for the medical records, and 12.6% for the review of the discharge form. The overall sensitivity of the review of medical records was 88%. The sensitivity value for discharge forms was 56%. It was concluded that the retrospective method involving the review of
medical records is the most efficient active surveillance strategy in detecting nosocomial infection in surgical patients. The study illustrates how retrospective surveillance has the benefits of time efficiency. A total of 20 hours a week was needed for the prospective data collection, 8 hours for medical records review and 4 hours for discharge review (Belío-Blasco et al., 2000). Birnbaum and King (1981) found the median sensitivity value increase from 50% to 70% after 18 months of prospective surveillance. A time efficient approach is described by Costel et al. (1985), the system is called the abbreviated system involving the review of microbiological reports.

Established HAI surveillance systems in individual healthcare settings can be evaluated according to their accuracy and validity in detecting a true HAI event. As shown above sensitively and specificity values are used as measures for evaluating the system’s accuracy and data quality.

3.6.3 Frameworks for evaluating systems

The articles reviewed in the previous section described the evaluation of HAI surveillance systems using validity measures. This section reviews frameworks that are used to assess systems.

The Donabedian model is a paradigm for assessing the quality of healthcare; it is a conceptual framework which has been used by many health units to examine and evaluate the quality of care, including whole system measures (Brien and Ghali, 2008), nursing practices (Koch, 1992, Idvall et al., 1997), and surgical care (Hammermeister et al., 1995). Information regarding quality of care can be classified under three main categories: “structure”, “process”, and “outcome”. All three categories are connected, with good structure increasing the likelihood of good process and good processors increasing the likelihood of good outcome (Donabedian, 1988). The Donabedian Model is a well-accepted holistic framework for evaluating quality of healthcare. The preliminaries to quality assessment including who is being assess? What activities are being assessed? How are these activities supposed to be conducted and what are they meant to accomplish? These questions must be considered and agreed upon before assessment commences. The framework does not include an implicit definition of quality of care, allowing it to be used in
a broad or narrow scope when assessing a system (Donabedian, 1966). Although the framework has been applied and widely recognised in many healthcare related fields. It was developed by the physician, Avedis Donabedian, to assess the quality of care in clinical practice (Koch 1992). For the purpose of evaluating surveillance systems in DHB hospitals there are evaluation criteria that focus on the examining surveillance systems specifically. Criteria for evaluating surveillance systems will be discussed.

The CDC’s 2001 guidelines for evaluating public health surveillance systems provide methods for reviewing the operation of the public health surveillance system. Important questions that should be considered when describing the purpose and operation of the surveillance system are outlined in the framework to include: what are the planned uses of the data from the system? What is the period of time of the data collection? What are the reporting sources of data for the system? How are the system’s data managed (the transfer, entry, editing, storage, and back up of data)? How are the system’s data analysed and disseminated? If appropriate, what is the level of integration with other systems? The guidelines also recommend developing a flow chart of the system implemented (German et al., 2001).

The later 2004 framework further describes criteria for evaluating public health surveillance systems for early detection of outbreaks. The framework is organised into four categories, which involve attributes for surveillance evaluation. The categories include:

- System description
- Outbreak detection
- System experience
- Conclusions and recommendations

System description involves identifying the purpose of the surveillance system, the stakeholders involved and all aspects of the operation including data flow, data sources, data processing, statistical analysis, and epidemiological analysis. Outbreak detection relies on the timeliness of the surveillance approaches, measuring the validity of the system using operational definitions, baseline estimation, reporting delays, data characteristics, and outbreak characteristics. The validity of the system also relies on data quality that is complete and representative. The ‘system experience’ describes the performance attributes.
There are six key areas for the description: system usefulness, flexibility, system acceptability, portability, system stability, and the system costs. The conclusion and recommendations of the framework involve an evaluation to summarise the strengths and weaknesses of the system (Buehler et al., 2004).

### 3.6.4 Criteria for evaluating HAI surveillance systems

Criteria for the specific evaluation of HAI surveillance system have been documented in the literature. This section reviews the criteria used for the evaluation of HAI surveillance system.

The desired characteristics of a nosocomial infection surveillance system established by the WHO (2002) which was adapted from Thacker et al. (1988), incorporate the CDC’s criteria for evaluating public health surveillance systems. The desired characteristics of the system include:

- **Timeliness** - is the information collected and reported in a suitable time period
- **Simplicity** - to minimise cost and workload and promote unit participation
- **Flexibility** - to allow for change when appropriate
- **Acceptability** - can be evaluated by the level of participation and reasonable cost
- **Representativeness** - the exhaustiveness of the system

The quality of the data collected is evaluated using sensitivity, specificity, positive and negative predictive values. Quality indicators are also useful measures for evaluating the system (Thacker et al., 1988).

The overall usefulness of a HAI surveillance system is based on seven key attributes in McKibben et al. (2006). The criteria include the desired characteristics identified by the WHO (2002). The attribute *simplicity* (1), describes the structure and ease of operation, it considers case definitions, staff training, methods of data collection and entry into an internet-based software programme, and analytical reporting. Another attribute (2) is *flexibility*, which concerns the system’s ability to adapt to changing information needs or operating conditions with minimal time, funding, or personnel costs. The third attribute (3) is *data quality*, which includes measures of validity and completeness of recorded data, including sensitivity values and positive predictive values. *Acceptability* (4) is the willingness of sponsors and data reporters to participate in the system. *Representativeness* (5) describes
the system’s accuracy to identify the occurrence of the event over time and its distribution in the population. The *timeliness* (6) of the system is divided into four steps: the occurrence of the event, its recognition, the reporting of the event to appropriate recipients, and the feedback to stakeholders for quality improvement decisions and action. The final concept (7) is *stability*, which describes the system’s ability to perform reliably and is operationally stable (McKibben et al., 2006).

The Advisory Committee on Antimicrobial Resistance and Healthcare Associated Infections (ARHAI) was established on 2007 to provide advice on surveillance priorities in the United Kingdom (ARHAI 2011). An ARHAI sub-committee was developed to review existing surveillance schemes in the UK and to make recommendations on how to improve national surveillance. A scoring pro forma was developed to review surveillance system (Wilson and Kiernan, 2012). The desirable features of HAI surveillance systems incorporate key components of HAI surveillance systems as described in section 1.5. These key features outlined by Wilson and Kiernan (2012) include:

- Clear defined objectives
- Reproducible data
- Performance measures against national comparators
- Data informing local services and commissioners
- Post-discharge surveillance
- Minimal extra resources
- Integration with other health service data management systems
- Incorporation into routine service delivery
- Rapid feedback of information
- Professional and infection prevention support and review procedures
- Links with other national surveillance systems

### 3.6.5 Development of HAI surveillance evaluation framework

This literature review has demonstrated key components that HAI surveillance system should incorporate as well as key concepts that should be used when evaluating HAI
surveillance systems. With this knowledge, it is possible to produce a framework to evaluate the DHB hospitals’ HAI surveillance systems.

There are different approaches to HAI surveillance, identifying the method used provides information on how data is collected and transferred. The first part of the framework will be used to describe the types of surveillance methods used for HAI data collection; this includes active/passive, patient-based/laboratory-based, prospective/retrospective, targeted/comprehensive approaches and post-discharge surveillance. The simplicity of the method for data collection and entry into an internet-based software programme and analytical reporting will be reviewed.

The second section will evaluate the data collection for numerator and denominator data, the clarity and consistency of definitions applied, and the type of data collected will be reviewed.

The third section evaluates the characteristics of the surveillance system, involving the timeliness, accuracy, application, analyses, validity, acceptability, and integration of HAI surveillance information. Timeliness incorporates the time period of data collection and feedback. The accuracy of the system involves the system’s ability to identify the occurrence of the event over time and its distribution in the population. The application of the HAI data encompasses the dissemination of HAI data locally and externally informing services, infection prevention, and control support. The analyses and validity of the system will be used to review the data quality and reproducibility of the data obtained; it measures validity and completeness of recorded data, including sensitivity values and positive predictive values. Acceptability and integration of the system addresses the willingness of sponsors and data reporters to participate in the system. It will review the HAI surveillance systems integration with other health service data management systems, as well as the systems incorporation into routine service delivery and links with other national surveillance systems. These characteristics will be used to review the surveillance systems used in DHB hospitals. Figure 3 shows the overall framework developed to assess HAI surveillance systems in DHB Hospitals.
### Description of the type of surveillance system used:

- Active/Passive
- Patient-based/Laboratory-based
- Prospective/Retrospective
- Targeted /Comprehensive

### Sources for data collection:

**Numerator data**
- Demographic information
- Infection information
- Risk factors information
- Laboratory information
- Radiology/imaging information

**Denominator data**
- Counts cohorts of patients at risk of acquiring HAI
- Obtain data on operations from operating room logs or patient charts for patients who have devices inserted.

### Characteristics of the surveillance system:

- Timeliness
- Accuracy
- Application
- Analyses and validity
- Acceptability and representativeness

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**Figure 3. Framework developed to assess HAI surveillance systems in DHB Hospitals**

### 3.7 Literature review summary

The key components for HAI surveillance involve determining clear objectives for HAI surveillance, selecting appropriate methods and case definitions, with the feedback of information in a timely manner to those who need to know so that action can be taken, is critical to the success of a surveillance programme. The utilisation of computer databases and software programmes are an effective method for improving accuracy and reducing resources and the time required to conduct adequate surveillance. The CDC’s NNIS/NHSN system has been adapted by many counties including Australia, England, Germany, and France. An evaluation framework to review the surveillance systems for HAIs in DHB hospitals has been developed which incorporates the methods used for data collection and analyses, the data sources for numerator and denominator data, and components concerning the timeliness, accuracy, application, analyses and validity and acceptability and integration.
4 Methods

4.1 Introduction

This research project has three key objectives:

1. To identify and review the fundamentals of HAI surveillance and to establish international best practice
2. To conduct an in depth case study of HAI surveillance in SDHB hospitals
3. To identify the HAIs surveillance performed in other national DHB hospitals

The methods and results for objective 1 are shown in chapter 3- the literature review. To determine the systems used in Dunedin and Southland hospitals for the surveillance of healthcare acquired infections (HAIs) and to identify the surveillance systems used in other major District Health Board (DHB) hospitals in New Zealand, two separate research methods were used: semi-structured interviews and a self-administered questionnaire. Interviews were used to gain an understanding of the surveillance performed in SDHB hospitals and the questionnaire was used to determine the type of HAI surveillance implemented in other New Zealand DHB hospitals. This section describes the approach to the development, implementation and analysis of the SDHB interviews and national HAI surveillance questionnaire.

4.2 Project planning and consultation with Southern DHB

Prior to the study, HAI surveillance at Dunedin Hospital involved reporting to a variety of groups, with no overall control and minimal internal reporting. SDHB hospital’s medical and nursing directors were consulted and it was established that there was a need to identify the current approach to HAI surveillance in SDHB hospitals and to identify the links between the two hospitals to create a more cohesive approach to surveillance within SDHB.

Auckland City Hospital, the main hospital of Auckland DHB is championing many infection prevention and control programmes. The New Zealand hand hygiene programme was initially piloted in Auckland City Hospital and evaluations of the hand hygiene programme and cost assessment studies concerning HAIs have been implemented in Auckland City Hospital. The infection control team in Auckland City Hospital are involved in HQSC infection
control programmes, including the development of the SSI surveillance initiative, and have vast knowledge in infection control activities implemented in New Zealand. Members from infection control at Auckland City Hospital were consulted to establish an idea of the types of surveillance programmes and initiatives currently implemented in Auckland City Hospital, in New Zealand and the direction of the SSI national surveillance programme.

4.3 Ethical approval, Māori consultation and other considerations

Approval was jointly granted by the SDHB and Dunedin School of Medicine, Research Advisory Group (RAG) for interviewing SDHB staff. The Ngāi Tahu Research Consultation Committee was consulted about the research and supported the investigation. Ethical approval was sought from the Human Ethics Committee of the University of Otago under category B, for the interviews with SDHB staff and for participants in the national HAI surveillance DHB questionnaire.

4.4 Study objective two: Method for Interviews with staff from SDHB

4.4.1 Interview content development

Pre-determined questions and topic areas were developed from the literature review. These topic areas include key concepts for HAI surveillance and elements from the NNIS/NHSN systems. The key questions include those that were identified in CDC’s Guidelines for Evaluating Surveillance (German et al., 2001) and the established framework for evaluating HAI surveillance systems. An outline of the semi-structured interview questions is found in Appendix 1.

The main types of HAIs identified from the literature were BSIs, SSIs, UTIs, and pneumonia; questions were asked about the types of infections monitored and the areas within hospital that they are monitored. The key components of HAI surveillance systems identified in the literature review were investigated. The definitions for the types HAIs monitored and the frequency of data collection and reporting were investigated. Questions were asked to gather a description of the surveillance performed which aimed to determine the denominator and numerator information collected, methods used for data collection and analysis and the overall approach to HAI surveillance in the hospital.
Questions were asked to determine the timeliness of system and if there are any similarities to established international HAI surveillance systems. The feedback and dissemination of the collected data was investigated and questions were asked about the planned uses of collected data, i.e.- how is the system’s data analysed and by whom and how? Who receives data or reports? How often is data disseminated? Are there any governmental policies or other external reporting?

The importance of databases and software programme is emphasised in the literature. Questions were asked regarding the use of databases, software programmes or a manual paper-based system for the collection and storage of data. Inquiries concerning the integration of other hospital systems such as pharmacy and radiology were also made. The perceived strengths and weaknesses of surveillance activities were investigated to understand how hospital personnel regard the systems in place and if any recommendations for improvement should be made.

Questions were altered according to the hospital area that the interviewee was representing. For example, surgical personnel were asked about post-discharge surveillance, personnel from NICU personnel were asked about denominator data concerning birth weight categories, and adult ICU personnel were asked about the collection of patient line days for denominator data.

Once information was obtained from certain areas or concerning specific types of infection, these ideas were discussed in other units. For example, it was initially determined that MDROs and BSIs were identified as under continual surveillance by the IPC team. I subsequently inquired if other infections are monitored in the same manner.

4.4.2 Interview participant selection
Discussion with study sponsors also led to the production of an initial starting list of key informants for interviews, which included members from the infection prevention and control team. Informants were subsequently identified based on their position in high risk HAI priority areas defined from the literature. The NNIS system included four standardised protocols for hospital-wide surveillance, ICUs, high risk nursery, and surgical patients. In the
context of SDHB hospitals these areas include IPC staff performing hospital-wide surveillance and surgical wards including the maternity ward and adult and neonatal intensive care units.

A hospital memo was also sent to relevant clinicians and service managers. I attended the infection prevention and control committee meeting to explain the details of the research project and to request participation for interviews.

Interview participants were additionally asked if they knew of any other hospital personnel who could provide additional relevant information. Email addresses of suggested interviewees were taken; and if the suggested personnel agreed to an interview, a time was arranged and an interview carried out.

4.4.3 Interview process

Interviews took place between May and July 2012. Potential informants were first contacted through email and a request for an interview was made along with an attachment of the information sheet. Interview times were subsequently arranged with those who expressed interest in the research project. The semi-structured interviews were scheduled to take around 40-60 minutes to complete with around twelve questions asked.

The interview always began with an explanation of the study; I stated to the interviewee that I am aiming to gather an understanding of the HAI surveillance performed in their hospital, and would like information concerning the HAI data collected and reported. A description of HAI surveillance activities was provided at the start of each interview. These initiatives are identified in the literature as activities that contributed to any of the following areas: Increasing sensitivity to infection control problems and identifying areas with possible infection control problems; obtaining confirmation of possible infection control problems; analysing reasons for infection control problems; and the feedback of relevant information regarding HAIs to clinical and managerial staff. Following this description a brief summary of the WHO surveillance definition was provided. The definition was phrased as: the on-going systematic collection, analysis and interpretation of health data essential to the planning, implementation and evaluation of practice, and the feeding back of relevant information to clinical and managerial staff.
If the participant was unsure about any questions or topics that were raised during an interview I would ask if they knew anyone else within the hospital that would be able to provide further information. If they did not know anyone else, then I would raise the topic with other participants who belong to the same unit to provide insight.

Once accounts concerning the information flow of HAI events were identified, an information flow diagram was produced, as according to the guidelines from German et al. (2001). The study sponsors were consulted to ensure the correct documentation of committees and personnel involved in each group. In subsequent interviews I enquired about HAI information being transferred to the identified groups and modified the diagram accordingly.

To obtain an overview of surveillance performed in the hospital, the first interview was with the infection control. A total of 17 interviews were performed with clinical and managerial staff from SDHB hospitals. Table 6 shows the hospital areas and the number of staff interviewed from the unit. Participants from Dunedin Hospital included members of infection prevention and control, microbiology, infectious diseases, surgical area, maternity, clinical coding, adult and neonatal ICU and IV therapies. Following a series of interviews with Dunedin Hospital staff, interviews commenced at Southland Hospital, involving infection control, microbiology, and quality control.

An information sheet outlining the research was given to each participant before the interview took place. This ensured that participants had time to acquaint themselves with the research and ask questions or express any concerns. At the time of the interview, participating SDHB staff members who agreed to participate in the study were requested to sign a consent form. Copies of the information sheet and consent form are located in Appendix 2 and Appendix 3 respectively. An audio recorder was used during the interviews, which was used for transcribing.

All interview participants were encouraged to talk freely about what they felt was important to surveillance and topics outside of the pre-determined questions were also covered. Informants were asked to describe their involvement in HAI surveillance, how surveillance information was collected, reviewed, forwarded and stored as well as what they perceived to be the strengths and weaknesses of the HAI surveillance system. Interviews stopped
taking place when all high risk units were covered and when interviewees were asked about other possible hospital personnel to interview, but no new names were provided.

Table 6. The number of SDHB hospital personnel participating in interviews

<table>
<thead>
<tr>
<th>Dunedin Hospital area that the member is from</th>
<th>Number of staff members contacted</th>
<th>Number of staff members who participated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neonatal intensive care unit</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Adult intensive care unit</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Maternity unit</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Surgical areas</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Provided surgical information through email</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>IV Therapies</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Infection Prevention and Control</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Coding</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Microbiology/Infectious disease</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Quality and risk</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Paediatrics</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>30</strong></td>
<td><strong>22</strong></td>
</tr>
</tbody>
</table>

| Southland Hospital area that the member is from |
|-----------------------------------------------|----------------------------------|
| Infection control team                        | 2                                |
| Microbiology                                  | 1                                |
| Quality and risk                              | 1                                |
| Paediatrics                                   | 1                                |
| **Total**                                     | **30**                           | **22**                                 |

4.4.4 Interview data analysis:

The information obtained from the interviews was used to identify the surveillance systems currently implemented in SDHB hospitals. I transcribed each recoded interview directly on a Microsoft Word document. The 4-8 page transcripts were then summarised to 2-3 pages and sent back to the interviewee through email to ensure that the information obtained was correct and not misleading. Informants were also given the opportunity to retract any statements or to provide additional information.
I reviewed the interview transcripts and descriptions of the surveillance activities performed, the type of data collected and methods used, and the transfer of information were tabulated and summarised. The summaries were then categorised into surveillance activities for each monitored HAI ie- BSIs, MDROs, CLAB, line–associated sepsis, SSIs and C. difficile.

The HAI surveillance evaluation framework developed in chapter four was used to review the surveillance systems in different hospital areas. The types of methods used in each priority area were categorised according to the following methods: active/passive, patient-based/laboratory-based, prospective/retrospective, target/comprehensive. The type of data collected was categorised into numerator and denominator data. HAI surveillance forms used for data collection were provided from the interview participants involved in data collection. In accordance to the evaluation framework, the numerator data collected was reviewed for demographic patient information, information regarding the infection and risk factors, and sources of data i.e.-laboratory, radiology/imaging. The source of denominator data was also reviewed to identify if counts of patient at risk are determined and if patient charts or operating room logs are used to gather information. Key attributes of surveillance systems involving timeliness, acceptability and integration, accuracy, application, and analyses and validity were also used as themes to evaluate the current systems used.

4.5 Study objective three: Method for national HAI surveillance questionnaire

4.5.1 Questionnaire content development

The questionnaire was established to assess the surveillance system used in major DHB hospitals. The main ideas and themes expressed in key informant interviews, along with information obtained from the literature review facilitated the development of the questionnaire. The questionnaire examined the types of HAIs monitored at the chosen hospital and how often the data is collected, reported, and fed back to relevant personnel. The self-perceived validity, timeliness, accuracy, analysis, and application of surveillance data were explored in the questionnaire, as well as strengths and weaknesses of the HAI surveillance system. The first two pages of the questionnaire incorporated general surveillance questions to obtain information concerning the overall approach to surveillance. This section collected information concerning perceived strengths and weaknesses of surveillance performed, the types of infection control committees/groups that exist in the
organisation that deal with HAI data and members included in the IPC team, as well as the overall approach to HAI data analyses and data storage.

The interviews with SHDB staff identified that HAI priority units implement their in-house surveillance and may focus on certain infections which are common or significant in their unit. Protocols and methods used for certain HAI surveillance varied from each unit and type of infection. Therefore, the questionnaire was designed to have eight sections, to allow for sections to be forwarded to relevant specific hospital areas if needed, or to be disregarded if the section was not applicable. Each section had a focus on one of the main HAIs identified through the literature review and the main infections identified by SDHB staff during interviews. These HAIs are BSIs, SSIs, CLAB infections, cUTIs, VAP, MDROs, and C. difficile infection. It was evident though the interviews that hospital units focus on specific HAIs. Questions were asked to understand the hospital areas that perform surveillance for certain types of HAI or specific infecting microorganisms e.g.- Staphylococcus aureus, E.coli, Klebsiella.

The HAI evaluation framework developed was used to establish the HAI surveillance questionnaire. The type of surveillance methodology used for each type of HAI was investigated through yes/no/unsure questions, along with a space for comments. Active surveillance was investigated by asking the questionnaire participant if “patients are monitored by observation for the development of a (specific type of HAI) during their hospitalisation, with IPC personnel screening relevant reports and discussing with medical staff possible HAI cases”. Passive surveillance was investigated by asking “personnel who do not have a primary surveillance role (ward nurses, doctors or therapists) to identify and report the HAI to IPC personnel”. Laboratory based surveillance was inquired about by asking if “the microbiologist notifies the IPC personnel on HAI cases”. Retrospective surveillance: “The HAI is identified via chart reviews after the patient discharge”. Targeted surveillance: “HAI surveillance is targeted at patients undergoing specific medical procedures or at risk of developing a specific HAI”. Outbreak threshold surveillance: “surveillance data only evaluated when the number of isolates of a particular species or number of positive blood cultures exceed an outbreak threshold”.
Denominator data collection was investigated by asking: “denominator data for calculating rates of infection is collected by counting the cohort of patients at risk of acquiring a HAI infection”. The reporting of HAI data collected was investigated through asking if “the IPC team documents monthly infection rates and create graphs and charts” and if a report is produced and presented to the IPC committee, or to an equivalent group regarding infection rates for specific HAI s.

The frequency of data collection or reporting in each DHB hospital were explored for each type of HAI, with tick boxes for continuously, daily, weekly, monthly, and annually along with spaces for other intervals or comments. Components for evaluation of surveillance system identified in the evaluation framework were investigated through self-perceived criteria. Participants were able to rate their HAI surveillance system as “excellent”, “very good”, “good”, “fair”, or “poor” according to the following categories: the timeliness of data collection and reporting of surveillance data, validity of data collected, application of HAI surveillance data collected, analyses of HAI surveillance data, and the accuracy and completeness of numerator and denominator.

The common strengths identified in the SDHB interviews concerned integration, communication, data transfer, a simplified surveillance method, and professional sensitivity. The common weaknesses identified in the interviews include the absence of certain HAI s, definitions and protocols and a systematic reporting system, the need for an integrated database and local HAI targets and benchmarks, as well as poor engagement from staff and feedback to clinical staff. These experienced strengths and weaknesses were provided on the questionnaire as tick box options to identify common themes in surveillance strengths and weaknesses shared between DHB hospitals. Free text boxes were also included to allow participants to express further strengths and weaknesses.

A pilot version was sent to the infection control charge nurse manager of Dunedin Hospital and a meeting was arranged to provide feedback. After consultation and feedback the questionnaire was altered to include more tick box questions with less writing required from the participant. Examples were provided for certain questions to help explain the question and avoid misunderstandings. For example, the question investigating the storage of data
provided the examples of an Access or Excel spread sheet. A general statement at the beginning of the questionnaire was included to determine the types of infections under surveillance in each hospital. If a certain infection is not monitored in the hospital then no further information was required; this prevented the team from having to complete non-relevant questions.

The questionnaire was developed on a Microsoft Word document and was then transformed into a fillable PDF form. The questionnaire titled “Questionnaire to Review of Healthcare Acquired Surveillance” is found in Appendix 4.

4.5.2 Selection of questionnaire participants

The DHB hospitals for questionnaire recruitment were identified by the location of the hospital in the major city in the DHB area, based on population size of the city. Table 2 located in chapter 2, shows the main hospitals in each DHB. The infection control nurse specialist or charge nurse specialist was identified as performing the central HAI surveillance and having the greatest understanding concerning the surveillance performed in the hospital. The literature review further supported that active surveillance should be performed by trained IPC professionals. Therefore it was decided that the questionnaire should be completed by the infection control charge nurse, nurse specialist or equivalent.

The 2012 New Zealand DHB Infection Control Nurses Directory was made available by the Infectious Disease Charge Nurse Manager of Dunedin Hospital. The head infection control nurse specialist from each of the major DHB hospitals identified was contacted via telephone and details of the research project and what was required from them was explained. Each consenting nurse was then emailed a copy of the questionnaire and an information sheet outlining the research and how the questionnaire data would be used.

4.5.3 Questionnaire process

Once the chosen participant was contacted and had agreed to participate in the questionnaire an information sheet outlining the research objectives and implications along with the questionnaire was sent to the participants through DHB hospital email accounts. A copy of the information sheet is found in Appendix 5. Participants were provided with the
option of returning the completed questionnaire through email or by post. Free postage envelopes were made available on request. All participants selected to have the questionnaire emailed. Participants returned the questionnaire through email, printed copies were sent to the Preventive and Social Medicine research student postal address.

4.5.4 Questionnaire data analysis

An Excel spread sheet document was used for data entry. Each survey question and response was entered onto an Excel spread sheet. The questionnaire was coded using numerical values yes= 1, no= 0, unsure= 2 for yes/no questions. Questions that involved more than yes/no response were divided into separate questions and then answered with a yes/no response. For example, question one of section A examines the hospital areas that are under surveillance for BSIs. Each selected response (hospital wide, ICU, NICU, maternity, surgical units) was categorised into a separate column in Excel and answered with a 1 (yes) or 2 (no).

Each section of the questionnaire was entered into a separate sheet but on the same Excel document. Data was analysed by frequency. Once every question was entered percentage values, graphs, tables and pivot tables were created using the Excel tools. Due to the small sample size it was not possible to apply statistical analysis. Where possible, information provided in the ‘other’ option and in free text boxes were established into meaningful categories according to key words in individual text responses.

Pivot tables were used to compare the participant’s perceptions of timeliness to actual frequencies of data collection and reporting for each of the main HAIs investigated: BSIs, SSIs, CLAB infections, cUTIs, VAP, MDROs, and C. difficile infection. The self-perceived application of HAI surveillance data was compared to the different groups/committees that receive and report data. Self-perceived analyses of HAIs data was compared to the different methods of analyses performed. Participant’s perceived strengths and weaknesses were tabulated into graph form and common themes were identified. Questionnaire results were grouped to provide an overview of the surveillance performed and to review the systems used according to the evaluation framework.
5 Results

5.1 Introduction
The results obtained from the investigation are described in this chapter. Results are divided into two key sections: the first section provides the case study interview results from Dunedin Hospital and Southland Hospital (study objective 2 results). The second section describes the questionnaire results from national DHB hospitals (study objective three results). Both sections provide a description of the overall approach to surveillance in DHB hospitals obtained through interviews or questionnaires, followed by an evaluation of surveillance systems with the criteria developed in chapter four.

5.2 HAI surveillance implemented in Dunedin Hospital
This section provides an overview description of the HAI surveillance performed in Dunedin Hospital. Key members involved in infection prevention and control are described, followed by a description of the specific HAIs under surveillance in high risk areas. The infections include MDROs, BSIs, line-associated infections, CLAB, caesarean wound infections, and other SSIs. Perceived strengths and weaknesses of the HAI surveillance system identified by the main HAI hospital areas are displayed in Tables 7 and 8 respectively. A summary of the key component of surveillance performed by the main HAI hospital areas is in Table 9.

5.2.1 Infection Prevention and Control hospital personnel
The IPC team is made up of three part-time infection prevention and control nurses, one of which is the charge nurse specialist and the other two nurses look after different hospital areas in terms of infection prevention and control and data collections. The infectious disease (ID) physician and medical microbiologist meet two to five times a week to review interesting cultures or trends. Through the computer-linked hospital isolation notification system, medical microbiology notifies the IPC team and ID physician of certain infections such as C. difficile and MDROs. The ID physician is notified of the hospital-wide surveillance of BSIs and MDROs and is consulted on the events to prevent horizontal spread of infection, or treatment procedures. The ID physician is not involved in data collection or isolation, or lab confirmations. The IPC team follow-up on the patient to ensure correct procedures are implemented. The Infection Prevention Quality meeting is held monthly in Dunedin Hospital.
involving the IPC team, the clinical microbiologist, and infectious disease physician who meet to discuss the types of infections occurring within the hospital, any identified trends, and evidence of poor practice. The Infection Prevention Control Committee meets every two months and involves a broader range of hospital personnel including occupational health, public health, and hospital unit representatives. These meetings help to ensure that information is disseminated to the right people and members discuss daily working processes and comment on what they have been noticing.

5.2.2 Multi drug resistant organism and C. difficile surveillance

The IPC team in conjunction with the microbiology lab monitor MDROs (Extended spectrum beta lactamase-producing organisms, methicillin-resistant S. aureus, and multi resistant E. coli) and C. difficile throughout the hospital. The IPC charge nurse manager combines all data collected by the IPC team concerning MDRO and C. difficile infections and presents the data to the Infection Prevention Control Committee meeting. Incident reports concerning MDROs (and BSIs) are disseminated to the clinical staff on the wards by the IPC team. MRSA data involving new patients and staff members is reported at the infection control meeting: this data is collected by the IPC team who produce the reports for the meeting. This information can be a month behind and is only the summary result.

5.2.3 Bloodstream infection surveillance

The microbiology lab and IPC team also work together to perform BSI surveillance. The positive blood culture information originates from the microbiology lab. This information is reported to the ward where the culture originated from and also to the IPC team. The IPC team collate information and forward individual patient BSI summary forms back to the medical microbiologist. The form outlines patient details including the procedures carried out, types of devices inserted, co-morbidities (e.g. gastrointestinal problems), drugs they were on, organism causing infection, and confirmation of infecting organism. BSI data is logged into an Access database and the medical microbiologist produces a monthly BSI report. BSI reports are presented to the IPC Committee, and data of significance is subsequently transferred to the Quality Improvement Committee.
The medical microbiologist is responsible for determining if an infection was hospital or community acquired, or as a result of a contaminant. This determination is based on patient notes, lab information, and there are strict criteria for classifying as a HAI. Definitions originated from the Ministry of Health, and hospital acquired BSIs were previously used as part of the key performance indicators for Dunedin Hospital. A BSI is considered to be hospital acquired if the infection occurs 48 hours or later from admission and was not incubating at the time of admission, or was related to the procedure performed when the patient was admitted to hospital.

5.2.4 Line-associated blood stream infections

Neonatal intensive care units (NICU) collect data on line-associated sepsis in neonates as part of the Australasian neonatal network. Any type of intravenous line inserted into a neonate requires a form to be filled, documenting the date of insertion and possible risk factors. The data is continuously collected on a paper-based form and once every month the NICU nurse responsible for the collation of the line-associated sepsis data enters the data into a NICU spreadsheet document. The nurse leading the project and the consultant of the unit discuss at the daily ward rounds every positive blood culture result from the microbiology lab to determine whether the detected microorganism was due to contamination or if the organism was causing an infection. Outbreaks and unusual cases would also be identified and discussed during these consultations. Information regarding infection rates and the administration of lines are reported annually to the Australasian group and yearly comparison data is provided to all participating NICUs.

Bi-monthly meetings are held with an IPC team representative, clinical microbiologist, the infectious disease physician, and NICU consultants. Trends and possible improvements are discussed at the meetings. Every three months, NICU produce a brief overview of infection rates to keep the IPC team informed on what is happening within the NICU. This information is incorporated into the general hospital system; there is no specific system for the reporting of HAI infections.
5.2.5 Central line-associated bacteraemia infection surveillance

As part of the national CLAB programme, the ICU is collecting information on the insertion of all central lines in patients in ICU. The project uses maintenance bundles, checklists, and data is collected and recorded on the number of CLAB infections in ICU. The project has a focus on ICU, but patients from other units are included as the national definition of a CLAB involves being tracked 48 hours after the insertion of the central line. CLAB data is collected through the National Central Venous Line Insertion checklist form. The clinical staff member who inserts or accesses the line is required to fill in the form. A form for each inserted line must be completed at every shift and forwarded to the ICU nurse responsible for collecting CLAB data. Numerator and denominator data concerning the CLAB is collected daily and data is then logged into the CLAB database with statistics and monthly reports generated. There are 12 beds in ICU and every day the ICU nurse counts and documents the number of patients in ICU that have a central line inserted and if an infection has developed. The number of central line days is determined by the total number of days a central line is in place for patients. A target of zero CLABs per 1000 line days has been set and number and rates of infection is determined.

The clinical microbiologist and the clinical lead of ICU meet twice a week to determine whether the identified positive cultures meet national definitions for bacteraemia or if the positive culture is a contaminant. When a CLAB is identified, a series of questions are answered on the CLAB form to provide an indication of why the event occurred. Every month a report on CLAB infections is submitted to the nursing directors, IPC team, clinical microbiologist and the hospital CEO. The relevant personnel respond to the monthly reports stating if CLAB rates are what they expect or if rates are of concern and need further investigating. CLAB rates are also reported nationally to Ko Awatea, the group in partnership with HQSC leading the CLAB programme. The reporting helps to identify where each DBH hospital is in terms of their central lines infections in ICU.

5.2.6 Caesarean wound infection surveillance

Maternity patients are monitored during their time as hospital inpatients and post-discharge surveillance takes place four to six weeks after the patient has been discharged. A post-discharge caesarean wound infection form, which helps to identify the presence of a
caesarean infection, is sent to the lead maternity carer looking after the patient in the community. The caesarean infection form gathers information about the possible infection, the treatment as well as the risk factors of infection. The collected data is then sent back to maternity ward for data entry and analysis performed by a nominated caesarean section wound surveillance midwife. A report is presented annually at the maternity teaching session attended by obstetricians and midwives (in-house and community). The continuously collected post-discharge data is logged onto a database approximately every month. The database is separate from daily use patient information system. It is similar to an Excel spreadsheet allowing the production of graphs and charts. Every three months the charge midwife manager in the maternity ward reviews the surveillance information to detect if rates are increasing and information is discussed in-depth at the annual training session. The rates of infection for every three months are forwarded to the IPC team by a nominated midwife who reports caesarean wound infection data. A report outlining the possible reasons for the caesarean wound infections is not provided to the IPC team; only the actual infection rates are provided. Outside of QM there is minimal collaboration with groups; once the IPC team are given the 3 monthly results they discuss infection rates, and occasionally the infection control team would also pass on articles relating to caesarean wound surveillance to the Queen Mary Maternity staff.

The Queen Mary Maternity quality group consisting of the charge midwife manager, a health and safety representative, an infection control representative, midwives, and service managers meet monthly to discuss perceived problems but infection rates are not discussed every month as data is reviewed every three months. The in-house Queen Mary quality group reports to the hospital’s Quality Improvement Committee if the three monthly reviews indicate a significant issue. Otherwise discussion happens once a year when the annual report has been produced. The Queen Mary Maternity ward engage in the BSI and MDRO surveillance carried out by the IPC team and microbiology lab.

**5.2.7 Surgical areas**

There was no system in place from routine SSI surveillance within the surgical areas. Information can be obtained as part of clinical practice and may be discussed at surgical morbidity and mortality meetings (M&M). Surgical complications are discussed at the M&M
meeting and often, cases can have an infective element, but not all infections are discussed due to the limited time available. The infection control team members or infectious disease physician do not attend these meetings or sit on other surgical committees, but they are attempting to become involved. SSI data collected by the surgical areas is largely opportunistic and occurs within each surgical area. Information obtained from the lab is stored as part of normal clinical notes and incorporated into the surgical audit database, but not actively analysed for surveillance. There is contact with the microbiology lab at an individual patient level as part of routine clinical practice. Confirmation on the infecting microorganism is reported back to clinical ward staff. Unusual detected infections also warrant further consultation with the microbiology lab and infectious disease physician. This process is part of clinical care, not for the purpose of surveillance, and is not identified as active monitoring. All general and plastic surgery patients are followed up one week after discharge by a phone call and six weeks later by a validated questionnaire. A trained nurse collects information on how the patient is going post-surgery and would pick up if the patient has developed an SSI. This information can be entered into the surgical audit database. Post-surgical infections can be missed if not associated with a BSI.

Email correspondence with surgical personnel
A clinical member from general surgery wrote back following my email requesting an interview stating that the infection prevention and control team members would be the best people to contact as they do surveillance on HAI rates and that the surgical areas would not be able to provide additional information. The surgical member stated that the surgical units often do not know patients have an infection as they are discharged. They may later present with an infection to their General Practitioner. The clinical member from orthopaedics wrote back stating that they are unsure whether there is any on-going surveillance in orthopaedics and that there had been various projects done there in the past in Dunedin Hospital and at Mercy Hospital. The member also stated that the IPC team would have more information.

5.2.8 Other HAI surveillance
The ICU would like to develop a system for the surveillance of other HAIs such as ventilator associated pneumonia (VAP) and SSIs. These infections are reported on the individual patient record but not externally into a database where rates can be determined. The orthopaedic team previously collected information on joint infections as part of
requirements to the Ministry of Health, but this project was removed a year ago and is no longer in action. The IPC team would only notice something if they see the trend themselves. The IPC team have identified that communication between the surgical units could be improved and are currently working towards improving the information feedback from surgical units. Orthopaedic and cardiothoracic surgery is performed regularly at Dunedin Hospital and the IPC team is trying to gain acceptance from these units in order to report their surgical infection rates in a systematic way. They want to work together to obtain reliable data.

Table 7. Perceived strengths of HAI surveillance implemented in Dunedin Hospital

<table>
<thead>
<tr>
<th>Types of HAIs and hospital areas</th>
<th>Strengths of the surveillance system</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSIs and MDRO surveillance (IPC team)</td>
<td>Performed with a simplified standard methodology that all members of the IPC use. Good communication and collegiality within the IPC team. The daily reporting of isolations from the lab, and wards allows for the quick feedback of data. Surveillance information that is collected is transferred through various channels appropriately. All personnel involved are interested in making improvements.</td>
</tr>
<tr>
<td>BSIs and MDRO surveillance (Medical microbiologist and ID physician)</td>
<td>Clinical and managerial staff members are interested in looking at infection rates and want to make improvements, with all those who want to attend the IPC committee meetings attending. The IPC team have a lot of respect from staff as they are willing to investigate any possibility of an outbreak and they are proactive in trying to stop events before they escalate. The team also have a good working relationship with medical microbiology.</td>
</tr>
<tr>
<td>Caesarean wound infection surveillance (Maternity ward)</td>
<td>All patients who underwent a caesarean procedure are included in the post-discharge surveillance programme. The lead maternity carers are in a perfect position to collect information as they meet up with the patient post-discharge and have established good relationships with the women. Midwives are able to recognise symptoms and understand SSI definitions. There is a dedicated midwife who ensures data is collected, analysed and forwarded to relevant personnel.</td>
</tr>
</tbody>
</table>
The CLAB programme has great acceptance in ICU and is nationally well received.

Routine monitoring reinforces their actions on hand hygiene, protocols for inserting lines and care for IVs. It is a comprehensive system with mechanisms in place to gather and look at the data and make changes accordingly from the data for improvements.

The detection of SSIs is clinically based with clinicians responsible for collecting and reporting surgical site infections. Any data collected is anonymous, in terms of operating surgeons.

<table>
<thead>
<tr>
<th>Hospital areas</th>
<th>Weaknesses of the surveillance system</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSIs and MDRO surveillance (IPC team)</td>
<td>No coordinated approach for collection and communication of results. Surveillance is time consuming and little is known about the application of collected data. Minimal utilisation of the technology available e.g.- Software programme, causing the duplication of work when writing and reporting data. There is a need for an instant system that staff on the ward could potentially use to improve time efficiency. There is no national approach to surveillance; there is a need for a standard definition and approach. Only a few medical staff attends the IPC committee meetings as they have patient care duties. There has been no feedback from medical staff concerning infection rates so it is unknown if they are receiving and reading information from the IPC committee meeting. Minimal surgical site infection surveillance is performed.</td>
</tr>
<tr>
<td>BSIs and MDRO surveillance (Medical microbiologist and ID physician)</td>
<td>Surveillance of HAIs requires many resources and time for implementation. There is no IPC software programme. Very few medical staff attends the IPC committee meetings due to clinical responsibilities during the day. There is no feedback from medical staff concerning infection rates. Therefore there is uncertainty as to whether staff are receiving and reading minutes from IPC committee meetings. The Ministry of Health initiate infection control and surveillance programmes E.g.- surveillance of <em>S. aureus</em> BSIs, but they are short lived, which is frustrating for hospital personnel as time and resources are put into the programme and little is done with the collected data.</td>
</tr>
<tr>
<td>Area</td>
<td>Issue</td>
</tr>
<tr>
<td>------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>Caesarean wound infection surveillance (Maternity ward)</td>
<td>The system is labour intensive as the midwife who leads the surveillance must also carry out her normal midwifery duties. There is a need for the database to become integrated into the normal clinical practice system as the current system uses an ad hoc Excel spread sheet.</td>
</tr>
<tr>
<td>CLAB surveillance (ICU)</td>
<td>The CLAB project does not receive the time that it deserves. There is no surveillance database that incorporates other HAIs such as SSIs and VAP.</td>
</tr>
<tr>
<td>Line-associated sepsis (NICU)</td>
<td>Weakness surround compliance and making sure surveillance forms are correctly filled out.</td>
</tr>
<tr>
<td>SSI surveillance (Surgical areas)</td>
<td>There is a need for a robust system for collecting, analysing data and reporting data back to the clinical staff so that changes can be made.</td>
</tr>
</tbody>
</table>
Table 9. Summary of the surveillance performed by main HAI groups in Dunedin hospital

<table>
<thead>
<tr>
<th>Description of HAI surveillance performed in specific hospital areas</th>
<th>IPC Team and Microbiology Lab</th>
<th>Queen Mary Maternity Ward (Dunedin)</th>
<th>Intensive Care Unit (ICU)</th>
<th>Neonatal ICU (NICU)</th>
<th>Surgical units (orthopaedics, general, plastics)</th>
</tr>
</thead>
</table>

**Description of HAI surveillance performed in specific hospital areas**
- The IPC team in conjunction with the microbiology lab monitor blood stream infections, multi drug resistant organisms and *C. difficile* in Dunedin Hospital.
- Four-six weeks after patient is discharged, the community midwife assesses the patient for signs of infection and data is recorded and sent to the hospital for analysis and data entry.
- As part of the national central line-associated bacteraemia (CLAB) programme, ICU collect data on the insertion of all central lines in patients in ICU.
- A paper-based form is filled for every line inserted in neonates and especially for development of infection as part of the Australasian neonatal study.

**Stakeholders-hospital personnel collecting and using generated data.**
- Positive blood cultures identified by microbiology lab are forwarded to the ward and to the IPC team. The clinical microbiologist produces reports which are presented to the Infection Prevention and Control Committee and subsequently to the Quality Improvement Committee.
- Community maternity carers collect the post-discharge data. Inpatient data and analysis is performed by a midwife in the hospital and presented at the maternity education forum. Surveillance data is sent to IPC to senior management and to the clinical governance meeting, but with little feedback.
- An ICU nurse is responsible for data collection. Information is forwarded to ICU clinical lead and charge nurse, the hospital quality team, nursing directors, IPC team, microbiology lab, the IV committee and the CEO. Data reported externally.
- An ICU nurse is responsible for the collaboration of line-associated sepsis data. By-monthly meetings are held with IPC, the clinical microbiologist, the infectious disease physician and NICU consultants to discuss surveillance data.
- Data not actively collected but as part of clinical practice, surgical infections may be discussed at surgical Morbidity and Mortality meetings. The M&M meetings are attended by surgeons, surgical nurses and occasionally service managers.

**Data storage and management**
- All collected surveillance information is stored electronically on a database. There is no synchronised hospital-wide software.
- Surveillance data is logged into a database, which is similar to an Excel spread sheet but separate from clinical practice.
- Database programme called Static; every patient in ICU and every procedure performed is logged into the database.
- Data collected using a paper-based system and subsequently transferred to spread sheet.
- As part of normal clinical practice, patient infection data is stored in normal clinical notes and incorporated into the surgical audit database.
5.3 Description of the HAI Surveillance System used in Southland Hospital

Southland Hospital follows a similar baseline protocol to Dunedin Hospital for the surveillance of HAIs. Southland Hospital does not have a clinical microbiologist or infectious disease physician to disseminate information and provide further consultation. The microbiology lab and infection control (IC) team of Southland Hospital work together to perform surveillance of HAIs in the hospital. The infection control committee involves a broad group of Southland Hospital staff, including representatives from microbiology, sterile services, critical care, the emergency department, public health, paediatrics, pharmacy, quality, occupational health, and meeting minutes also go to the chief nurse.

This section describes the surveillance of specific HAIs: BSIs, MDROs, CLAB, caesarean wound infections and other SSIs. Perceived strengths and weaknesses identified by Southland Hospital personnel are displayed in Tables 10 and 11 respectively.

5.3.1 Bloodstream infection surveillance

BSI surveillance is implemented hospital wide, with positive blood cultures analysed monthly in order to determine if the event was hospital acquired and documentation of the infection organism is made. BSIs from adult and neonatal ICU are sent to the infection control team who look for similarities, cross infections and also for possible reasons for infection. A report on BSI is presented to the infection control committee by the infection control team, and rates of infection and unusual cases are discussed. Rates of \textit{S.aureus}-BSIs were previously sent to the financial department of SDHB, as numbers were required as part of a Ministry of Health initiative; this initiative is no longer implemented.

5.3.2 Surveillance of multidrug resistant organisms

MDROs are identified by the microbiology lab and the medical microbiologist reports bi-monthly to the infection control committee on MDROs. Methicillin-resistant \textit{S. aureus} and extended spectrum beta lactamase infections are the main MDROs discussed. The infection control committee meets every two months to discuss unusual cases and unexpected rates of infection. Once the data is obtained, the microbiology lead correlates, graphs, and identifies trends from the data. The MDRO information is also presented in the Hospital Advisory Committee report and on education days. All suspected cases of \textit{C. difficile}
infections are forwarded to the infection control team who then investigate all positive infections and look for possible reasons for why the infection occurred and annual reports are generated.

5.3.3 Surgical site infection surveillance
Surveillance on cesarean wound infections is performed in the maternity ward. In-patient information is collected by midwives in the maternity ward and post-discharge surveillance data is collected by the lead maternity carers using cesarean wound infection surveillance forms. The collected information is disseminated to the Southland Hospital infection control team. A report is produced by the team and is presented to the infection control committee, to the women’s and children’s directive, to the managers of maternity, and also to the independent midwives. An annual report will also be produced and if infections rates are noted as being problematic, then surveillance will continue as a point prevalence survey or as continuous monitoring. Other surgical site infections are not monitored unless the infection is caused by a MDRO.

5.3.4 Central line-associated bacterium (CLAB) infection surveillance
The national CLAB project is not in place in Southland Hospital. Infections from critical care are reported to the IPC team from the microbiology lab through the electronic system. This is the same method used for all infections, not just focusing on HAIs. Members of the infection control team occasionally ring the lab for further clarification on the microorganism; however no routine surveillance is performed.

5.3.5 Other HAI reporting programmes
A report is sent quarterly to the senior management group (SMG) which allows the IC team to provide the SMG with recommendations and express any changes that have occurred or actions that have occurred. MDRO and BSI data is also presented on education days providing an opportunity for information to be disseminated back to the clinical staff. When an incident regarding certain infections occurs, such as norovirus or extended spectrum beta lactamase infections, the IC team would be present in the clinical wards formulating a response plan, and the information regarding such infections would be forwarded to the nursing director, medical managers and executive teams.
Health Round Table (HRT) data is also available for identifying rates of HAIs as well as recognising how SDHB hospitals compare to other Australasian hospitals. The CEOs of DHB hospitals in New Zealand and the equivalent in Australia have agreed to be part of the collaborative group. Raw data from patient clinical records identifying the presence of an HAI are gathered and sent to the HRT group; the ICD 10 codes are used. The data sent to the HRT has not been analysed or manipulated in any way. An infection is classified as a HAI if the patient did not have an infection on arrival but left with an infection. Every six months a report is made available to the participating organisations. Hospitals within each country are compared to an exemplar hospital; an exemplar hospital is a hospital with low rate of infections but comparable in terms of size, the procedures they perform and the type of patients they get. This allows hospitals to contact the exemplar hospitals and discuss how they are keeping their numbers low (or high according to what is being investigated). There is an agreement that is made by all participating hospitals that information produced in these reports will not be published elsewhere. The hospital is able to publish and discuss their own result publicly if required. It was expressed by one interviewee that the HAI reports produce by the HRT are not fully utilised. Awareness of the HRT reports has increased, but there needs to be a system where the information is discussed and possible improvements made. There are acknowledged limitations with the data sent to the HRT as patients could be incubating a microorganism and the HRT report relies on doctors and nurses to correctly document the infection.

Table 10. Perceived strengths of HAI surveillance implemented in Southland Hospital

<table>
<thead>
<tr>
<th>Hospital Areas or type of HAI</th>
<th>Strengths of the surveillance system</th>
</tr>
</thead>
</table>
| The infection control team  | The IC team and committee are passionate and highly involved in the organisation.  
                                 | The electronic isolation notification link system from the microbiology lab to the IC team allows the IC team to be notified continually and obtain all necessary details. |
| BSIs and MDRO               | The graphing of BSI and MRDOs has been helpful allowing for trends to be detected and provides a method for the sharing of information to staff members. |
| SSIs- Caesarean wound infection | The caesarean wound infection surveillance is now implemented by the clinical area giving them ownership and regular information on rates of caesarean wound infections. |
Table 11. Perceived weaknesses of HAI surveillance implemented in Southland Hospital

<table>
<thead>
<tr>
<th>Hospital Areas or type of HAI</th>
<th>Weaknesses of the surveillance system</th>
</tr>
</thead>
<tbody>
<tr>
<td>The infection control team</td>
<td>There needs to be more graphing and presentation of HAI rates as it allows for trends to be detected and gives real information to clinical staff so they are reminded about infection control practices and become involved in creating improvements.</td>
</tr>
<tr>
<td></td>
<td>There is a need for a systematic method for information to be presented back to the clinicians and nurses.</td>
</tr>
<tr>
<td>BSIs and MDROs</td>
<td>The dissemination of BSI data to the units and directives could be improved so that they are aware of their infections rates and can track their progress.</td>
</tr>
<tr>
<td>SSIs</td>
<td>Currently surveillance for surgical site infections is fragmented and inconsistent.</td>
</tr>
<tr>
<td></td>
<td>It was stated by the interviewee that the national surgical recommendations will create a standardised method for data collection and reporting allowing for comparable and consistent data.</td>
</tr>
</tbody>
</table>

5.4 Integration of SDHB hospitals

The infection control team from Southland Hospital and the infection prevention and control team from Dunedin Hospital meet several times a year on education days and have teleconferences regularly and there is now work being done to combine the reporting system for HAIs and to implement similar electronic systems as they are under the same DHB. The infectious disease physician and the clinical microbiologist visit Southland Hospital on a regular basis (usually bi-monthly). Information on infections in Lakes district is also sent to the infection control team. A written report is produced by the IC team for Southland Hospital and Lakes District Hospital. The report is presented at the infection control committee meeting.

5.5 Summary of interview results

The IPC team in Dunedin Hospital perform continuous HAI surveillance for bloodstream infections, multidrug resistant organisms and *C. difficile* infections throughout the hospital. The maternity ward performs their own in-patient and post-discharge surveillance for caesarean wound infections. Neonatal and adult intensive care units implement their own in-house surveillance on line-associated infections as part of the Australasian neonatal network, and the adult ICU performs surveillance of CLAB as part of the Health Quality and
Safety Commission's Central Line-Associated Bacteraemia project. There is no routine surveillance in place for the collection and reporting of surgical site infections. Figure 4 shows the distribution of HAI reports in Dunedin Hospital and Figure 5 shows the information flow of HAI data in Southland Hospital.

The microbiology lab and infection control team in Southland Hospital work together to perform inpatient surveillance on BSIs and MDROs. BSI surveillance is implemented hospital wide, with positive blood cultures analysed monthly in order to determine if the event was hospital or community acquired. Caesarean wound infection data is collected by the maternity ward with information disseminated to the infection control team. There is no system in place for SSI surveillance that the microbiology and infection control team are notified on. A written report is produced by the infection control team for Southland Hospital and Lakes District Hospital. The report is presented at the infection control committee meeting.

Both Dunedin and Southland Hospitals report to the Health Round Table (HRT), which is an Australasian initiative. Raw data concerning HAI rates identified through clinical coding is reported to the HRT. Every six months a report from the HRT is available and hospitals of the same composition are compared according to key performance indicators.
Infection Prevention Quality meeting
IPC team, microbiologist and infectious disease physician meet monthly.

Infection Prevention Control Committee
Held every two months, personnel from a range of areas attend and discuss infection control issues.

Quality Improvement Committee
Personnel who run sub committees attend. HAI rates are not discussed in detail, only if there is a significant issue.

Clinical Board Meeting
An Otago site board attended by nursing and medical directors and an incident coordinator. Relevant infection information reported to the clinical board (hand hygiene, vaccination rates, and sharps injuries).

Quality Improvement Committee
Personnel who run sub committees attend. HAI rates are not discussed in detail, only if there is a significant issue.

Infection Prevention Control Committee
Held every two months, personnel from a range of areas attend and discuss infection control issues.

Infection Prevention Quality meeting
IPC team, microbiologist and infectious disease physician meet monthly.

Microbiology Lab
IPC team notified on isolation cases, BSIs, MDROs and C. difficile infections.

Surgical units
Surveillance not routinely implemented.

NICU
Monthly line-associated sepsis infection rates reported to IPC.

ICU
CLABs data shared monthly.

Queen Mary
Three monthly caesarean wound infection results shared.

Wards
Clusters and isolation notifications come from the wards, if not already from microbiology lab.

IPC Team
Feedback incident reports on BSI and MDROs to wards.

Clinical Board Meeting
An Otago site board attended by nursing and medical directors and an incident coordinator. Relevant infection information reported to the clinical board (hand hygiene, vaccination rates, and sharps injuries).

Quality Improvement Committee
Personnel who run sub committees attend. HAI rates are not discussed in detail, only if there is a significant issue.

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Held every two months, personnel from a range of areas attend and discuss infection control issues.

Infection Prevention Quality meeting
IPC team, microbiologist and infectious disease physician meet monthly.

Surgical units
Surveillance not routinely implemented.

Clinical Board Meeting
An Otago site board attended by nursing and medical directors and an incident coordinator. Relevant infection information reported to the clinical board (hand hygiene, vaccination rates, and sharps injuries).

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Infection Prevention Quality meeting
IPC team, microbiologist and infectious disease physician meet monthly.

Surgical units
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Clinical Board Meeting
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Surgical units
Surveillance not routinely implemented.

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An Otago site board attended by nursing and medical directors and an incident coordinator. Relevant infection information reported to the clinical board (hand hygiene, vaccination rates, and sharps injuries).

Quality Improvement Committee
Personnel who run sub committees attend. HAI rates are not discussed in detail, only if there is a significant issue.

Infection Prevention Control Committee
Held every two months, personnel from a range of areas attend and discuss infection control issues.

Infection Prevention Quality meeting
IPC team, microbiologist and infectious disease physician meet monthly.

Surgical units
Surveillance not routinely implemented.
Caesarean wound infection results shared to infection control.

Infection Control Committee held every two months, personnel from a range of areas attend and discuss infection control issues. Representatives from microbiology, sterile services, critical care, the emergency department, public health, paediatrics, pharmacy, quality, and occupational health attend the meeting.

Microbiology laboratory produces MDRO report.

Infection control informed on BSIs, MDROs and C. difficile infections through lab notification system.

Maternity Ward: Caesarean wound infection surveillance implemented in-house.

Infection Control Team

Education days: MDRO and BSIs presented on education days providing an opportunity for information to be disseminated back to clinical staff.

Hospital Advisory Committee: Report produced when required.

Senior Management Group: Report sent quarterly.

Infection Control Committee: Held every two months, personnel from a range of areas attend and discuss infection control issues. Representatives from microbiology, sterile services, critical care, the emergency department, public health, paediatrics, pharmacy, quality, and occupational health attend the meeting.

Microbiology Laboratory

Figure 5. Information flow of HAI events at Southland Hospital.
5.6 Evaluation of HAI Surveillance Systems case study results using framework criteria

This section evaluates the HAI surveillance systems implemented in Dunedin and Southland Hospitals using the evaluation criteria developed in chapter four. BSI and MDRO surveillance is performed by the IPC team actively in a retrospective manner. The other HAIs- caesarean wound infections, CLAB infection, and line-associated sepsis infections are monitored through an active, laboratory, prospective targeted approach. Both Dunedin and Southland Hospitals use the same methods for surveillance of MDROs, BSIs and caesarean wound infections. CLAB and other line-associated sepsis infections are not routinely monitored in Southland Hospital. There is no routinely performed SSI surveillance in Dunedin and Southland Hospitals. The methodology of HAI surveillance data collection is summarised in Table 12. Table 13 displays the numerator and denominator data collected; the surveillance forms used by the hospital units and IPC team for data collection were reviewed, and some of the information collected is presented in the table. The concepts of timeliness, application, accuracy, and analyses of surveillance data is described in Table 14.
<table>
<thead>
<tr>
<th></th>
<th>BSI (Dunedin and Southland Hospitals)</th>
<th>MDROs and <em>C. difficile</em> (Dunedin and Southland Hospitals)</th>
<th>Caesarean Wound Infections (Dunedin and Southland Hospitals)</th>
<th>CLAB (Dunedin Hospital)</th>
<th>Line-Associated Sepsis (Dunedin Hospital)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Active/ Passive system</strong></td>
<td>Active- performed by infection control</td>
<td>Active- performed by infection control</td>
<td>Active- performed by maternity ward and community midwives</td>
<td>Active- performed by ICU personnel</td>
<td>Active- performed by NICU personnel</td>
</tr>
<tr>
<td><strong>Patient based/ Laboratory based</strong></td>
<td>Laboratory-based</td>
<td>Laboratory-based</td>
<td>Patient-based</td>
<td>Patient-based</td>
<td>Patient-based</td>
</tr>
<tr>
<td><strong>Prospective/ Retrospective</strong></td>
<td>Retrospective</td>
<td>Retrospective</td>
<td>Prospective and Retrospective- Post discharge</td>
<td>Prospective- Patients are monitored once line inserted</td>
<td>Prospective- monitored once line inserted</td>
</tr>
<tr>
<td><strong>Targeted/ Hospital wide</strong></td>
<td>Hospital wide</td>
<td>Hospital wide</td>
<td>Maternity ward- Targeted</td>
<td>ICU- Targeted</td>
<td>NICU- Targeted</td>
</tr>
</tbody>
</table>

* The active/passive approach to surveillance is from the perspective of the unit area performing the specific HAI surveillance e.g.- Adult ICU perspective for CLAB infections.
Table 13. Numerator and denominator data collection in Dunedin Hospital

<table>
<thead>
<tr>
<th>Demographic information collected</th>
<th>BSI (Dunedin and Southland Hospitals)</th>
<th>MDROs (Dunedin and Southland Hospital)</th>
<th>Caesarean wound infections (Dunedin Hospital)</th>
<th>CLAB (Dunedin Hospital)</th>
<th>Line-associated sepsis (Dunedin Hospital)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient’s age, sex.</td>
<td>Patient’s age, sex.</td>
<td>Patient’s age.</td>
<td>Patient’s age, sex.</td>
<td>Patient’s age, sex.</td>
<td>Patient’s age-in terms of days, sex.</td>
</tr>
<tr>
<td>Infection details and information</td>
<td>Organism causing infection, confirmation of infection from micro lab.</td>
<td>Lab confirmation of infecting microorganism- Extended spectrum beta lactamases, MRSA, multi resistant E. coli.</td>
<td>Caesarean wound form gathers information on infection-redness, swelling, ooze blood or fluid. Superficial wound infection or deep wound infection.</td>
<td>Lab confirmation, infecting microorganism and drug sensitivities.</td>
<td>Organism causing sepsis, simultaneous infection causing septicaemia. Sensitivity to antibiotics- cephalosporin and gentamicin.</td>
</tr>
<tr>
<td>Laboratory/radiology/imaging data</td>
<td>Conformation of infection from the laboratory notification system.</td>
<td>Laboratory.</td>
<td>Infection detected by community midwife.</td>
<td>Laboratory.</td>
<td>Laboratory and haematology evidence.</td>
</tr>
<tr>
<td>Counts of patients at risk of HAI- denominator</td>
<td>No.</td>
<td>No.</td>
<td>Yes- all patients who had a caesarean.</td>
<td>Yes- all patients with a central line.</td>
<td>Yes- all patients with an inserted line.</td>
</tr>
<tr>
<td>Data obtained from patient charts or operating room logs</td>
<td>Patient charts- Charts reviewed when patient is detected with infection.</td>
<td>Patient charts- Charts reviewed when patient is detected with infection.</td>
<td>Patient charts- data collected on all caesarean patients through surveillance form.</td>
<td>Patient charts - data collected on all patients with line administered through surveillance form.</td>
<td>Patient charts- data collected on all patients with line administered through surveillance form.</td>
</tr>
</tbody>
</table>
Table 14. Key attributes of the surveillance system

<table>
<thead>
<tr>
<th>Attribute</th>
<th>BSI (Dunedin and Southland Hospitals)</th>
<th>MDROs and <em>C. difficile</em> (Dunedin and Southland Hospitals)</th>
<th>Caesarean wound infection (Dunedin Hospital)</th>
<th>CLAB (Dunedin Hospital)</th>
<th>Line-associated sepsis (Dunedin Hospital)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Timeliness</strong></td>
<td>IPC team are notified on BSI result as soon as the lab confirms the infection. Data is presented to the IPC committee every two months.</td>
<td>IPC team are notified on MDROs and <em>C. difficile</em> after lab confirmation. Data is presented to the IPC committee every two months.</td>
<td>Data continuously collected. Three-monthly review of data and reported annually to the Maternity teaching session.</td>
<td>Data continuously collected and reports are produced monthly for stakeholders.</td>
<td>Data continuously collected as each line is inserted, logged monthly into a database. Reports are produced annually for the Australasian study.</td>
</tr>
<tr>
<td><strong>Acceptability and Integration</strong></td>
<td>Incident reports concerning BSI is disseminated to clinical staff, feedback of overall ward rates at regular intervals does not occur.</td>
<td>Incident reports concerning MDROs disseminated to clinical staff, feedback of overall ward rates at regular intervals does not occur.</td>
<td>One midwife responsible for data collection. Data submitted to IPC team every three months and little collaboration outside of maternity ward.</td>
<td>ICU staff have been receptive to CLAB programme, on-going documentation with each central line inserted.</td>
<td>A line insertion form is filled in by clinical staff as part of patient care.</td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>Notification from lab only.</td>
<td>Notification from lab only.</td>
<td>Every discharged caesarean patient is reviewed. Detection of infection based on observation. Response rates vary.</td>
<td>Every inserted line is continually assessed.</td>
<td>Every inserted is line-assessed.</td>
</tr>
<tr>
<td><strong>Application</strong></td>
<td>IPC collates collected data and discuss results at monthly infection prevention quality meetings and IPC committee meetings. No data feedback to wards.</td>
<td>IPC collates collected data and discuss results at monthly infection prevention quality meetings and IPC committee meetings. No data feedback to wards.</td>
<td>Queen Mary quality group receive data, significant issues would then get referred to QIC.</td>
<td>Monthly reports submitted to relevant personnel and feedback is obtained. Data reported to national programme.</td>
<td>Each infection discussed on daily rounds and weekly departmental meetings. Information regarding infection rates is reported externally to the Australasian group.</td>
</tr>
</tbody>
</table>
5.6 SDHB case study summary
The IPC team in Dunedin Hospital and the infection control team in Southland Hospital implement surveillance on BSIs, multidrug resistant organisms and *C. difficile* infections. The surveillance methods for these infections involve a hospital-wide, active, laboratory, retrospective approach. Surveillance forms are used to collect data on BSI, patient demographic information and possible risk factors. The maternity wards in both hospitals perform their own in-patient and post-discharge surveillance for caesarean wound infections. Neonatal ICU in Dunedin Hospital implement their own in-house surveillance on line-associated infections as part of the Australasian neonatal network and the adult ICU perform surveillance on CLAB infections as part of the Health Quality & Safety Commission’s Central Line-Associated Bacteraemia project. Both systems use an active, laboratory, prospective, targeted approach. There is no routine surveillance in place for the collection and reporting of surgical site infections.

5.7 HAI surveillance questionnaire results
The data presented in this section was obtained from the national HAI surveillance questionnaire collected during the period of September 1\textsuperscript{st} to November 30\textsuperscript{th} 2012.

5.7.1 Response rate
15 of the 20 (75\%) sent questionnaires were returned from the selected DHB hospitals. Participants who filled out the questionnaire included: nurse specialists in IPC (66.7\%), charge nurse managers in IPC (20\%), infection control advisors (6.7\%), and registered nurses in IPC (6.7\%).

5.7.2 Types of HAI s monitored
Most of the surveyed hospitals reported performing surveillance for all HAIs with the exception of cUTIs and VAP with 5 hospitals (33.3\%) and 3 hospitals (20\%) performing surveillance for these types of infections respectively. Figure 6 shows the percentage values of the types of HAIs under surveillance in the surveyed DHB hospitals.
In the free text boxes the hospitals surveyed reported performing surveillance on other types of infections. Chest infections were reported as incidents in 1 hospital surveyed. Intravenous line infections were under surveillance in 4 of the hospitals. Influenza surveillance was carried out in 2 of the hospitals during influenza season or as infections emerged. Epidural infection surveillance was reported in 1 hospital. Rotavirus, norovirus, staph infections, scabies, and all notifiable diseases were under surveillance in 1 hospital. Data on HAIs was reported as being collected for the hand hygiene NZ programme, Health Round Table reports and to the Australasian Council on Healthcare Standards for caesarean sections.

![Figure 6. Types of HAIs under surveillance in DHB hospitals](image)

5.7.3 Collection and storage of surveillance information

Hospitals reported surveillance information as being collected and stored using a paper-based method, an electronic system, or a combination of both paper and electronic methods. A paper-based system for the storage of data was used in 1 hospital, an electronic system was used in 60% (9) of the hospitals and 33.3% (5) of the hospitals reported using both a paper-based method for raw data collection and an electronic system for data storage and the generation of graphs and charts. The electronic systems used include the Epi Info database used by 6.7% (1) of the hospitals. Excel spread sheets were used in 53.3% (8)
of the hospitals, Access database software was used by 6.7% (1) hospital, and an electronic surveillance programme called ICNet was used by 6.7% or (1) hospital. These databases were used either in conjunction with a paper-based system for data collection or exclusively on their own. The type of electronic programme used was not described by 20% (3) of the hospitals.

5.7.4 Infection control teams and committees
There are a variety of committees that exist within the hospitals surveyed that review and report the HAI surveillance information. An IPC team was present in 80% (12) of hospitals, 77.3% (11) have an IPC committee, 20.0% (3) have an Antibiotic Committee, 53.3% (8) a Quality Improvement Committee, 53.3% (8) of the hospitals reported having clinical board groups, and 53.3% (8) hospitals reported having departmental meetings that review and report HAI surveillance information. Hospitals also reported in the free text boxes that the DHB internal intranet information is delivered to the patient safety committee, clinical and corporate governance, and also to external groups such as the Health Round Table group and the Australian Council on Healthcare Standards.

5.7.5 Infection Control team members
The IPC teams in DHB hospitals include several infection personnel. Clinical nurse specialists in IPC were in 93.3% (14) of hospitals surveyed, 80.0% (12) of the hospitals have a microbiologist in the team, 46.7% (7) of hospitals surveyed have an infectious disease physician, and 6.7% (1) hospital has a data manager/analyst. Table 15 shows the number of hospital personnel in the IPC team and the types of infections covered. The number of hospital personnel in the IPC team covering BSI, SSI, and CLAB infections was the same for the hospitals monitored. The number of personnel in the IPC teams covering cUTIS, MDROs, VAP and *C. difficile* infections varied. Hospitals with 5 or more members in the IPC team performed surveillance for all types of HAIs monitored with the exception of VAP surveillance. Hospitals surveyed with only 1 IPC team member covered 3 of the 7 HAIs investigated. Hospitals with 2 or more infection control teams covered 6-7 of the 7 HAIs surveyed.
Table 15. Number of hospital staff in the IPC team and the types of HAIs covered

<table>
<thead>
<tr>
<th>No. of staff in IPC team</th>
<th>BSI N=15</th>
<th>SSI N=15</th>
<th>CLAB N=15</th>
<th>cUTIs N=5</th>
<th>MDRO N=14</th>
<th>VAP N=3</th>
<th>CDI N=13</th>
<th>Total no. of HAIs covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>7</td>
</tr>
</tbody>
</table>

5.7.6 Self-perceived assessment on key criteria

Participants answering the questionnaire were asked to rate their own surveillance systems according to themes of timeliness, validity, accuracy and completeness of data, application, and the analysis of HAI surveillance data. Results of the questions are displayed in Table 16. Most hospitals rated themselves as “good” or “very good” in all the criteria.

Table 16. Self-perceived assessment on key criteria

<table>
<thead>
<tr>
<th>The timeliness of collecting and reporting surveillance data</th>
<th>Excellent</th>
<th>Very good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Not Applicable or Not Sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.7% (1)</td>
<td>20.0% (3)</td>
<td>40% (6)</td>
<td>33.3% (5)</td>
<td>0% (0)</td>
<td>0% (0)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The validity of data collected</th>
<th>Excellent</th>
<th>Very good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Not Applicable or Not Sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.3% (2)</td>
<td>40.0% (6)</td>
<td>26.7% (4)</td>
<td>13.3% (2)</td>
<td>6.7% (1)</td>
<td>0% (0)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accuracy and completeness of numerator and denominator data</th>
<th>Excellent</th>
<th>Very good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Not Applicable or Not Sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.3% (2)</td>
<td>33.3% (5)</td>
<td>13.3% (2)</td>
<td>20.0% (3)</td>
<td>13.3% (2)</td>
<td>6.7% (1)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The application of HAI surveillance data collected</th>
<th>Excellent</th>
<th>Very good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Not Applicable or Not Sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% (0)</td>
<td>26.7% (4)</td>
<td>40.0% (6)</td>
<td>20.0% (3)</td>
<td>13.3% (2)</td>
<td>0% (0)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analysis of HAI surveillance data</th>
<th>Excellent</th>
<th>Very good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Not Applicable or Not Sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.7% (1)</td>
<td>20.0% (3)</td>
<td>40.0% (6)</td>
<td>26.7% (4)</td>
<td>6.7% (1)</td>
<td>0% (0)</td>
<td></td>
</tr>
</tbody>
</table>
5.7.7 Reported strengths of the HAI surveillance system

Participating hospitals reported a range of perceived strengths and weaknesses. Figure 7 displays the strengths of HAI surveillance systems. More than half of the hospitals identified the strengths of the HAI surveillance system as good integration and communication with staff members and departments, information is transferred to the necessary personnel, identifies where mistakes are occurring and suggests improvements, and the most selected strength was professional sensitivity. There is no blame directed to clinicians and nursing staff. Fewer hospitals reported the use of a simplified method for data collection, analysis and reporting as strength of their HAI surveillance system. Other strengths identified in the free text boxes include the high IPC profile, access and availability, and a small IPC team who work well with each other.

![Figure 7. Reported strengths of the HAI surveillance implemented in surveyed hospitals](image)

5.7.8 Reported weaknesses of the HAI surveillance system

The weaknesses of the HAI surveillance system varied between the hospitals surveyed. Figure 8 shows the percentage values of the reported weaknesses of the HAI surveillance system. The most common weaknesses reported by hospitals surveyed concern the resource intensiveness of the surveillance system and the minimal medical staff involved in surveillance. Poor engagement from staff for data collection, poor feedback on HAI information to clinical staff and the absence of standard definitions, criteria and protocols
for HAI surveillance were the least common identified weakness. Weaknesses reported in the free text boxes generally concern the resource intensiveness of HAI surveillance and the need for an electronic system which integrates with other areas.

![Weaknesses of the Surveillance System](chart.png)

**Figure 8. Reported weaknesses of HAI surveillance implemented in surveyed hospitals**

### 5.7.9 Areas in hospitals where surveillance takes place

The seven categories of infections are monitored in various units and areas of the hospitals. Table 17 shows the different areas where surveillance of HAIs takes place. All hospitals performing BSI, MDRO, and *C. difficile* surveillance reported implementing surveillance hospital wide. All hospitals reported performing CLAB surveillance in intensive care units and 33.3% (5) of the hospitals reported performing CLAB surveillance hospital wide and in surgical units. Surveillance for cUTI is performed in intensive care units and surgical units with 80% (4) of the hospitals selecting these areas. All hospitals (3) implementing VAP surveillance perform surveillance in intensive care units and one hospital perform VAP surveillance hospital wide. Participants were able to select more than one area where surveillance is implemented.

### 5.7.10 Surgical areas under surveillance

All hospitals (15) reported performing SSI surveillance in the orthopaedic unit, 93.3% (14) performed SSI surveillance in the maternity wards for caesarean wound infections, 53.3% (8) of the hospitals performed SSI surveillance in general surgical areas, and 26.7% (4) of the
hospitals performed SSI surveillance in all surgical areas. Other surgical areas that were reported as being under surveillance were cardiac surgery reported in 20% (3) of hospitals, breast surgery in 13.3% (2) of the hospitals, and single hospitals reported performing surveillance on emergency surgery (6.7%), abdominal hysterectomies (6.7%), Lap Vholeys (6.7%), mastectomies (6.7%), chest (6.7%), and inguinal hernia repair (6.7%). The type of orthopaedic surgery carried out included elective, primary hip and knee joint replacement orthopaedics and clean orthopaedic procedures.

Table 17. Area of Hospital under surveillance for different HAIs

<table>
<thead>
<tr>
<th></th>
<th>BSIs N=15</th>
<th>CLABs N=15</th>
<th>CUTIs N=5</th>
<th>MDROs N=14</th>
<th>VAP N=3</th>
<th>C. difficile N=13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsure</td>
<td>0%</td>
<td>6.67% (1)</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Hospital wide</td>
<td>100% (15)</td>
<td>33.3% (5)</td>
<td>60% (3)</td>
<td>100% (14)</td>
<td>33.3% (1)</td>
<td>100% (13)</td>
</tr>
<tr>
<td>ICU</td>
<td>100% (15)</td>
<td>100% (15)</td>
<td>80% (4)</td>
<td>100% (14)</td>
<td>100% (3)</td>
<td>100% (13)</td>
</tr>
<tr>
<td>Neonatal ICU</td>
<td>100% (15)</td>
<td>26.7% (4)</td>
<td>60% (3)</td>
<td>100% (14)</td>
<td>33.3% (1)</td>
<td>100% (13)</td>
</tr>
<tr>
<td>Maternity ward</td>
<td>100% (15)</td>
<td>26.7% (4)</td>
<td>60% (3)</td>
<td>100% (14)</td>
<td>33.3% (1)</td>
<td>100% (13)</td>
</tr>
<tr>
<td>Surgical units</td>
<td>100% (15)</td>
<td>33.3% (5)</td>
<td>80% (4)</td>
<td>100% (14)</td>
<td>33.3% (1)</td>
<td>100% (13)</td>
</tr>
</tbody>
</table>

5.8 Evaluation of HAI national questionnaire results using framework criteria

This section evaluates the HAI surveillance systems implemented in DHB hospitals using the evaluation criteria developed in chapter four.

The methods used for the surveillance of HAIs vary for each hospital and for each type of HAI. The timeliness of information collected and reported by the IPC team also varies for each hospital and for each type of infection. Most hospitals reported continuous data collection and monthly reporting for all types of HAIs investigated, as outlined in section 5.5.9. Hospitals reported a varied approach for the analysis of collected HAI surveillance data. Section 5.6.2 describes the main approaches to analyses used by the surveyed DHB hospitals. More than half of the hospitals monitoring specific HAIs produced monthly HAI
rates and graphs/charts by the IPC team. Most hospital’s IPC team produce a report that is presented to the infection prevention committee or equivalent group regarding HAI rates.

5.8.1 Description of the type of surveillance methods used

The reported methods for carrying out HAI surveillance for the seven categories of HAIs is shown in Table 18. Patients were monitored by observation for the development of infection in all hospitals performing VAP surveillance, 80% (3) of hospitals performing SSI and CLAB infection surveillance, and 66.7% (10) of hospitals performing BSI surveillance. One hospital did not answer the question in the BSI and another did not answer the CLAB sections of the questionnaire.

The HAI was identified via chart reviews after patient discharge in 60% (9) of the hospitals performing SSI surveillance, in 53.3% (8) carrying out BSI surveillance, and in 46.7% of the hospitals performing CLAB surveillance. Less than half of the hospitals performing surveillance reported post-discharge surveillance for cUTIs (20% (1)), MDRO (21.4% (3)), VAP (33.3% (1)) and C. difficile (23.1% (3)). One hospital did not answer the question for the BSI and MDRO section and two hospitals did not answer the question in the CLAB section.

Personnel who do not have a primary surveillance role identify and report the HAI to IPC staff in all 100% (3) of hospitals performing VAP surveillance and in 60% (3) of hospitals performing cUTI surveillance. This approach was performed in 26.7% (4) of the hospitals for BSIs and SSIs surveillance. The question was not answered by one hospital completing the BSI, CLAB, MDRO and C. difficile sections.

The microbiologist notifies IPC on the HAI in all 100% (3) of hospitals performing VAP surveillance, in 84.6% (3) of hospitals performing C. difficile surveillance, 64.3% (9) performing MDRO surveillance, and 60% (9) for CLAB and BSI. The question was not answered by one hospital completing the MDRO section, one completing the CLAB section, and by two hospitals completing the BSI surveillance section of the questionnaire.
Surveillance targeted at patients undergoing specific procedures or at risk of HAI was performed in 66.7% (2) of the hospitals performing VAP surveillance and 66.7% (10) of hospitals performing SSI surveillance.

Surveillance data was only evaluated when the number of isolates exceeds an outbreak threshold in 14.3% (2) of hospitals performing MRDO surveillance and in 7.7% (1) of hospitals performing C. difficile surveillance.

Denominator data was collected by counting the cohort of patients at risk of acquiring the HAI in 93.3% (14) of hospitals performing SSI surveillance, in 66.7% (2) of hospitals performing VAP surveillance, and 53.5% (8) of hospitals performing CLAB surveillance. One hospital did not answer this question for the CLAB and BSI sections.
Table 18. Overview of the methods used for the different types of HAIs

<table>
<thead>
<tr>
<th>Patients monitored by observation for the development of HAI during hospital stay (Active Surveillance)</th>
<th>BSI* N= 15</th>
<th>SSIs N=15</th>
<th>CLAB ** N=15</th>
<th>cUTIs N=5</th>
<th>MDROs * N=14</th>
<th>VAP N=3</th>
<th>C. difficile* N=13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>66.7% (10)</td>
<td>80% (12)</td>
<td>80% (12)</td>
<td>40% (2)</td>
<td>42.9% (6)</td>
<td>100% (3)</td>
<td>53.8% (7)</td>
</tr>
<tr>
<td>No</td>
<td>20% (3)</td>
<td>13.3% (2)</td>
<td>13.3% (2)</td>
<td>60% (3)</td>
<td>50% (7)</td>
<td>0% (0)</td>
<td>46.2% (6)</td>
</tr>
<tr>
<td>Unsure</td>
<td>6.7% (1)</td>
<td>6.7% (1)</td>
<td>0% (0)</td>
<td>0% (0)</td>
<td>7.1% (1)</td>
<td>0% (0)</td>
<td>0% (0)</td>
</tr>
</tbody>
</table>

| The HAI is identified via chart reviews after patient discharge (Retrospective surveillance) | Yes | 53.3% (8) | 60% (9) | 46.7% (7) | 20% (1) | 21.4% (3) | 33.3% (1) | 23.1% (3) |
| No                                                                                 | 40% (6)    | 40% (6)  | 40% (6) | 60% (3) | 64.3% (9) | 33.3% (1) | 69.2% (9)  |
| Unsure                                                                             | 0% (0)     | 0% (0)   | 0% (0) | 20% (1) | 7.1% (1) | 33.3% (1) | 0% (0)    |

| Personnel who do not have a primary surveillance role identify and report the HAI to IPC staff (Passive surveillance) | Yes | 26.7% (4) | 26.7% (4) | 53.3% (8) | 60% (3) | 42.9% (6) | 100% (3) | 30.8% (4) |
| No                                                                                 | 66.7% (10) | 73.3% (11) | 40% (6) | 40% (2) | 42.9% (6) | 0% (0) | 61.5% (8) |
| Unsure                                                                             | 0% (0)     | 0% (0)   | 0% (0) | 0% (0) | 7.1% (1) | 33.3% (1) | 0% (0) |

| Microbiologist notify IPC on the HAI (Laboratory-based surveillance) | Yes | 60% (9) | 26.7% (4) | 60% (9) | 40% (2) | 64.3% (9) | 100% (3) | 84.6% (11) |
| No                                                                                 | 26.7% (4) | 66.7% (10) | 33.3% (5) | 60% (3) | 21.4% (3) | 0% (0) | 15.4% (2) |
| Unsure                                                                             | 0% (0)     | 6.7% (1) | 0% (0) | 0% (0) | 7.1% (1) | 0% (0) | 0% (0) |

| Surveillance targeted at patients undergoing specific procedures or at risk of HAI (Targeted surveillance) | Yes | 6.7% (1) | 66.7% (10) | 40% (6) | 20% (1) | 21.4% (3) | 66.7% (2) | 7.7% (1) |
| No                                                                                 | 86.7% (13) | 33.3% (5) | 53.3% (8) | 60% (3) | 64.3% (9) | 33.3% (1) | 84.6% (11) |
| Unsure                                                                             | 0% (0)     | 0% (0)   | 0% (0) | 20% (1) | 7.1% (1) | 0% (0) | 0% (0) |

| Surveillance data is only evaluated when the number of isolates exceed an outbreak threshold (Outbreak threshold) | Yes | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 14.3% (2) | 0% (0) | 7.7% (1) |
| No                                                                                 | 93.3% (14) | 100% (15) | 86.7% (13) | 100% (5) | 57.1% (8) | 100% (3) | 76.9% (10) |
| Unsure                                                                             | 0% (0)     | 0% (0)   | 6.7% (1) | 0% (0) | 7.1% (1) | 0% (0) | 7.7% (1) |

| Denominator data is collected by counting the cohort of patients at risk of acquiring the HAI (Denominator data collection) | Yes | 26.7% (4) | 93.3% (14) | 53.3% (8) | 40% (2) | 28.6% (4) | 66.7% (2) | 30.8% (4) |
| No                                                                                 | 66.7% (10) | 6.7% (1) | 40% (6) | 40% (2) | 64.3% (9) | 33.3% (1) | 61.5% (8) |
| Unsure                                                                             | 0% (0)     | 0% (0)   | 0% (0) | 20% (1) | 7.1% (1) | 0% (0) | 7.7% (1) |

*Percentage values may not add up to 100% for some questions as some hospitals did not answer the question.

** There are missing values from the CLAB section as the respondent stated that the methods used for CLAB surveillance is the same as the CLAB national programme regulations.
5.8.2 Timeliness of data collection and reporting

The frequency of information collection and reporting by the IPC team varies from each hospital and for each type of infection. Hospitals were able to select more than one frequency approach for data collection and reporting. Continuous data collection was the most common approach for data collection for all HAI categories with 73.3% (11) of the hospitals collecting continuous data on BSI, 46.67% (7) of the hospitals collecting continuous data on SSI and CLAB infections, 40% (2) collecting continuous data on cUTIs, 78.6% (11) of the hospitals collecting continuous data on MDROs, 92.3% (12) of the hospitals collecting continuous data on *C. difficile* infections, and all hospitals performing VAP surveillance (3) collected data continuously.

Monthly data reporting was the most common approach for HAI surveillance data reporting; 73.3% (11) of the hospitals reported BSI data monthly, 66.67% (10) of the hospitals reported SSI infections monthly, 66.67% (10) of the hospitals reported CLAB infections monthly, 40% (2) of the hospitals reported cUTIs monthly, 57.1% (8) of the hospitals reported MDRO infections monthly, 64.5% (8) of the hospitals reported *C. difficile* infections monthly, and all hospitals (3) performing VAP infection surveillance reported data monthly.

Surveyed hospitals also stated different time periods for HAI surveillance data collection and reporting. One hospital commented that reports for BSI are made every two months along with BSI- *S. aureus* infections reported to HQSC for the hand hygiene project. SSI surveillance data collection was identified as collected every 3 months by 20% (3) of the hospitals, every 6 months by another hospital, and in September/October yearly by another hospital. The SSI data was identified as being reported every 3 months in one hospital. Data for cUTI was identified as collected and reported every 6 months by 40% (2) of the hospitals. MRDO surveillance data was identified by 14.3% (2) of the hospitals as being reported when clusters become apparent or when there appeared to be an issue. Data was identified as being collected quarterly by 6.7% (1) of the hospital surveyed and reported every 2 months by 6.7% (1) of the hospitals performing CLAB infection surveillance. *C. difficile* infections were also reported every 2 months by 7.7% (1) of the hospitals and by another hospital every 3 months.
5.8.3 Analysis approach to collected HAI surveillance data

The hospitals surveyed reported using a combination of different approaches with some hospitals selecting more than one approach for the analysis of surveillance data. Rates of HAI for all patients are calculated for 60.0% (9) of the hospitals. Rates of HAI are calculated and controlled for variations in the distribution of major risk factors associated with HAI occurrence i.e.- calculated risk adjusted rates in 13.3% (2) of the hospitals. In 46.7% (7) of the hospitals, incidence rates are calculated by dividing the number of new HAI occurring during a given period by the number of patients at risk of acquiring an HAI during the period. Of the hospitals surveyed 13.3% (2) of the reported calculating prevalence rates using data on all patients who are being treated with an HAI at the time of data collection. Different methods for data analysis were reported by 13.3% (2) of hospitals; 1 hospital reported comparing only numbers, not rates as numbers are small but if a trend appears, then it is investigated. The other hospital implements target surveillance and the denominator is defined as all patients who underwent the surveillance procedure, and BSI rates are reported in two ways: as inpatients per month and rates of the total number of blood cultures performed.

5.8.4 Application of HAI surveillance data

The frequency of reports for HAI surveillance information varies for each hospital and for each type of infection monitored. Table 19 shows the application of the data collected concerning the seven categories of HAI. More than half of the hospitals monitoring specific HAI produced monthly HAI rates and graphs/charts by the IPC team. A report is produced and presented to the IPC team or equivalent group regarding HAI rates for all hospitals performing BSIs, VAP, and C. difficile infections, with 93.3% (14) of hospitals reporting SSIs and CLAB infections, 92.9% (13) reporting MDRO data, and 80% (4) of hospitals reporting cUTIs data.
<table>
<thead>
<tr>
<th></th>
<th>BSI N=15</th>
<th>SSIs N=15</th>
<th>CLAB N=15</th>
<th>cUTIs N=5</th>
<th>MDROs N=14</th>
<th>VAP N=3</th>
<th>C. difficile N=13</th>
</tr>
</thead>
<tbody>
<tr>
<td>The IPC team documents monthly HAI rates and charts/graphs</td>
<td>Yes</td>
<td>86.7% (13)</td>
<td>73.4% (11)</td>
<td>86.7% (13)</td>
<td>60% (3)</td>
<td>78.6% (11)</td>
<td>66.7% (2)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>13.3% (2)</td>
<td>20% (3)</td>
<td>0% (0)</td>
<td>40% (2)</td>
<td>21.4% (3)</td>
<td>33.3% (1)</td>
</tr>
<tr>
<td></td>
<td>Unsure</td>
<td>0% (0)</td>
<td>6.7% (1)</td>
<td>13.3% (2)</td>
<td>0% (0)</td>
<td>0% (0)</td>
<td>0% (0)</td>
</tr>
<tr>
<td>A report is produced and presented to the infection prevention committee or equivalent group regarding HAI rates</td>
<td>Yes</td>
<td>100% (15)</td>
<td>93.3% (14)</td>
<td>93.3% (14)</td>
<td>80% (4)</td>
<td>92.9% (13)</td>
<td>100% (3)</td>
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<tr>
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<td>No</td>
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<td>6.7% (1)</td>
<td>0% (0)</td>
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<td>7.1% (1)</td>
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</tr>
</tbody>
</table>
5.8.5 Self-perceived themes compared to reported methods for HAI

For this section of analysis ‘Not Applicable’ and ‘Other’ answers were treated as ‘No’. The self-perceived timeliness of HAI surveillance data collection and timeliness of data reported was compared to stated frequencies of HAI surveillance data collection and data reporting. Appendix 6, Tables 20-26 show the total values of self-perceived timeliness of data collection and reporting compared to the identified frequencies of data collection and reporting for BSI data (Table 20), SSIs data (Table 21), cUTIs infection data (Table 22), CLAB data (Table 23), VAP data (Table 24), MDRO data (Table 25) and C. difficile infection data (Table 26). The most common response for perceived timeliness of HAI surveillance data collection and reporting was “good” with 40% (6) of hospitals selecting this option; no hospitals reported their timeliness of collecting and reporting surveillance data as “poor” as shown on Table 16. Of these hospitals that reported “good” for timeliness, 5 collected data continuously and 4 hospitals reported data monthly for BSI (Table 20). For SSIs, 4 hospitals collected data continuously and 4 hospitals reported data monthly (Table 21). For CLAB surveillance, 2 hospitals collected data continuously and 4 hospitals reported data monthly (Table 23). For MDROs surveillance, 5 hospitals collected data continuously and 4 hospitals reported data monthly (Table 25). For VAP surveillance 2 hospitals collected data continuously and 2 hospitals reported data monthly (Table 24). For cUTIs 1 hospital collected data continuously with the informant perceiving their timeliness of surveillance data collection and reporting as “good”. One hospital perceived their timeliness as “very good” and collected cUTI data continuously and reported the data daily.

The most common response for the application of HAI surveillance data collected was “good” with 40% (6) of the hospitals selecting this option, as displayed in Table 16. These hospitals distribute their data broadly: 5 hospitals have an IPC team that review and report HAI surveillance data. In 4 of the hospitals HAI data is reported and reviewed in departmental meetings with data disseminated to medical staff and discussed in-house, and 3 have an IPC committee, a Quality Improvement Committee, and Clinical board groups that review and report HAI surveillance data. Appendix 6, Table 27 shows the selected self-perceived application of HAI data in comparison to the different committees and groups that exist in the hospital that review and report HAI surveillance data.
The most common response for the analysis of HAI surveillance data was also “good” with 40% (6) of hospitals selecting this option (Table 16). Of these hospitals, risk adjusted rates were calculated in 1 hospital, overall crude rates of HAIs were calculated in 2 hospitals, prevalence rates were calculated in 1 hospital and incidence rates in 5 of the hospitals. Appendix 6, Table 28 shows the selected self-perceived analysis of HAI data compared to the reported methods of analyses.
5.9 Summary of HAI surveillance questionnaire results

With the exception of cUTIs and VAP, most HAIs are under surveillance in DHB surveyed hospitals. The majority of hospitals surveyed have an IPC team and a broader committee that review and report surveillance information. Hospitals with 5 or more members in the IPC team monitored all infections with the exception of VAP. Most hospitals surveyed rated themselves as “good” or “very good” for the timeliness of collecting and reporting data, the validity of data collected, the accuracy and completeness of numerator and denominator data, the application of HAI surveillance data, and the analyses of HAI surveillance data. Of the hospitals that reported the timeliness of collecting and reporting surveillance data as “good” the majority stated that data is collected continuously and reported monthly. Most hospitals identified their application of HAI surveillance data as “good” and have an IPC team that review and report HAI surveillance data, and disseminate data to medical staff. Of hospitals that selected “good” for the analyses of data, the calculation of incidence rates was the most common form of data reported. The methods used for surveillance and the reporting of surveillance information vary for each DHB hospital and each type of infection.
6 Discussion

6.1 Introduction
This chapter provides a discussion of the research carried out in terms of methods, results, themes and implications. This discussion is based on the format developed by the British Medical Journal (Docherty and Smith, 1999). The chapter is divided into four sections: the first section provides a brief overview of the principal findings of the study; the second section interprets these results and evaluates these results using the framework criteria. The third section describes the strengths and limitations of this study in relation to other studies internationally and with available national data. The fourth part of this discussion focuses on the implications of the study for DHB hospital personnel, policy makers and other stakeholders. The direction for further research will also be discussed throughout this chapter.

6.2 Overview of principal findings

6.2.1 Principal findings from SDHB case study
The IPC team in Dunedin Hospital implement surveillance on BSIs, MDROs and C. difficile infections. The surveillance methods for these infections involve a hospital-wide, active, laboratory, retrospective approach. Surveillance forms are used to collect data on BSI, patient demographics and possible risk factors. The maternity ward performs their own in-patient and post-discharge surveillance for caesarean wound infections. Neonatal ICU implements their own in-house surveillance on line-associated infections as part of the Australasian neonatal network and the adult ICU perform surveillance on CLAB infections as part of the HCSQ’s CLAB project. Both systems use an active, laboratory, prospective, targeted approach. There is no routine surveillance in place for the collection and reporting of surgical site infections.

6.2.2 Principal findings from national HAI surveillance questionnaire
All of the surveyed DHB hospitals reported performing surveillance on BSIs, SSIs and CLAB; most hospitals perform surveillance on MDROs and C. difficile and only a few hospitals reported performing surveillance on cUTIs and VAP. An IPC team and broader committee are present in most hospitals who review and report surveillance information. Hospitals with 5
or more members in the IPC team monitored all infections with the exception of VAP. The methods used for data collection and reporting of surveillance information vary from each DHB hospital and for each type of HAI. Most hospitals surveyed rated themselves as “good” or “very good” for the timeliness of collecting and reporting of HAI surveillance information, for the validity of data collection, for the accuracy and completeness of numerator and denominator data, for the application of HAI surveillance data and for the analysis of HAI surveillance data. Of the hospitals that reported the timeliness of collecting and reporting surveillance data as “good”, the majority stated that data is collected continuously and reported monthly. Most hospitals that identified their application of HAI surveillance data as “good” have an IPC team that review and report HAI surveillance data and disseminate data to medical staff. Of hospitals that selected “good” for the analyses of data, the calculation of incidence rates was the most common form of data reported.

6.3 Interpretation of results
This study aimed to identify the current approach to HAI surveillance in New Zealand with a focus on SDHB. Prior to the study, the approach to HAI surveillance was unclear to SDHB study sponsors. It is imperative to understand the current approaches used for HAI surveillance in hospitals and their strengths and weaknesses before implementing new systems, in order to avoid the duplication of tasks, and allowing for efficient use of resources.

6.3.1 SDHB Case Study interpretation
6.3.1.1 Perceived strengths and weaknesses in SDHB hospitals
The perceived strengths of the HAI surveillance performed in SDHB hospitals varied between the different hospital areas investigated. The IPC team believe that the strength of the system is that the information collected is transferred out to the various channels with good communication and congeniality within the IPC team. Other units reported that their programmes have strong acceptance among staff members, and that routine monitoring reinforces their actions on hand hygiene and their infection control activities.

In regards to the weaknesses expressed, surveillance was perceived to be time consuming, and both human and resource intensive. The high risk hospital areas also believe that there
is minimal utilisation of the technology and databases causing duplication of work and minimal integration between IPC and other areas especially SSIs. There was an expressed need for a software programme that could be used by staff on the ward as well as the IPC team. The minimal feedback of data to medical staff was also identified as a common weakness. Electronic surveillance system for identifying and tracking infections has been proven to be a more efficient system than conventional surveillance methods, with such systems able to reduce the time spent on surveillance activities (Chalfine et al., 2006, Brossette et al., 2006). The ICNet software programme is currently used in Australia and has been piloted in Canterbury and Auckland and will shortly be installed in all DHB hospitals. ICNet provides a case management and surveillance software programme for SSI along with infection prevention and antimicrobial stewardship. It has a multi-lingual browser allowing for early case detection and reliable and consistent data. Infection information can be managed consistently and efficiently. Advanced reporting, benchmarking and local and national reporting can also be achieved which would save time and produce effective action. The utilisation of the software programme for all HAI s will help reduce the burden experience by the IPC teams.

6.3.1.2 Feedback/ dissemination of surveillance data

Surveillance is defined as the systematic on-going collection, collation, and analysis of data and the timely dissemination of information to those who need to know, so that action can be taken (Declich and Carter, 1994). HAI surveillance systems that provide timely information to hospital managers and clinicians to promote actions in infection prevention and control, result in reductions in HAI events (Sykes et al., 2005, Haley, 1985b). The dissemination of HAI surveillance data is a key component to HAI surveillance, as identified in the literature review.

BSIs, MRSA and C. difficile infections

On-going hospital-wide data collection occurs for BSIs, MRSA and C. difficile infections in SDHB hospitals. The IPC team collate BSI data received from the microbiology lab and subsequently return the collated information to the medical microbiologist who produces and reports monthly BSI information to the IPC committee and data of significance is reported to the Quality Improvement Committee. Firstly, it is difficult to comprehend what is
meant by ‘data of significance’. From my understanding there is no set threshold of BSIs. Rates from one time interval would be compared to previous intervals with normal fluctuations occurring, making it difficult to determine what is significant and what is normal without statistical analysis. Secondly, the data collected is not disseminated to the clinical areas directly. Incident reports on BSIs and MDROs are submitted to the clinical areas by the IPC team, but there is no collation of data with information disseminated back to where it originated from. The information feedback is currently reliant on committee groups feeding back the data.

Southland Hospital has a similar method for BSIs, MDRO and *C. difficile* surveillance and informants have also noted the need for a systematic method for data collection and feedback to clinicians and nurses. Clinical staff should receive timely reports on surveillance data along with descriptive information concerning numerator and denominator data in order to generate improvements and prevent infection (McLaws, 2011). The MDRO information is presented in the Hospital Advisory Committee report when requested as well as on Education Days. An informant reported that Education Days had been valuable to illustrate actual numbers of BSI and MDRO cases. These forums provide an opportunity for hospital personnel to engage in HAI issues and can take measures to help prevent HAIs.

Both the infection control teams from Southland and Dunedin Hospitals collect and collate surveillance information concerning BSIs, MDROs and *C. difficile* infections on an on-going basis. However, the timely dissemination of information to those who need to know so that actions can be taken does not systematically occur. Timely dissemination of information is a key element to surveillance, which is currently not implemented for important HAIs.

**CLAB infections and other line-associated sepsis**

The adult and neonatal intensive care units in Dunedin Hospital collect, collate and analyse surveillance data internally. Both units use an active, laboratory, prospective, targeted approach to HAI surveillance. Numerator and denominator data is collected using surveillance forms. Patient charts are reviewed to obtain the information required on the surveillance forms. These forms collect information concerning patient demographics, infection details, and information on risk factors. Data collection is similar between the adult
and neonatal ICUs. However, the two units report information to the IPC team at different intervals. The adult ICU report every month to IPC and three-monthly reporting is performed by the NICU. Subsequently, the IPC team does not forward any data, the Infection Control Committee do not receive information concerning line-associated sepsis from NICU. CLAB data is distributed monthly to relevant stakeholders by the CLAB project coordinator. Line sepsis data is transferred to the Australasian group, but to no groups or committees within SDHB. The reporting of CLAB data has been identified as working well within the organisation with relevant personnel receiving timely information. However, information concerning neonatal line-associated sepsis is not distributed externally in a timely manner. A method for information dissemination similar to that used for the CLAB initiative should be considered for line-associated sepsis data from NICU.

**Caesarean wound infection**

In-patient and post-discharge surveillance of caesarean wound infection data from the maternity ward is continuously collected. However, the timeliness of information reporting is delayed within the ward. Although information is reviewed every three months, clinical members do not receive information on collected data except during the annual feedback at the maternity teaching sessions. A substantial amount of time has passed before clinical staff receives notification of wound infection rates, unless significant events occur.

As surveillance information concerning caesarean wound infections and line-associated sepsis is collected by personnel in the unit and reported back to clinical staff within the same unit, an argument could be made to support in-house data collection and reporting. Without external linkage, ward staff may feel more comfortable collecting and reporting data. However, literature supports the notion that reporting information outside of a unit or organisation can produce initiatives to further reduce the occurrence of adverse events (Yokoe et al., 2008).

**6.3.2 Evaluation of SDHB case study using framework criteria**

**6.3.2.1 Surveillance methods**

Once the IPC team receive notification on a BSI or MDRO from the microbiology lab, they will investigate the case in a retrospective manner. Patients are monitored prospectively once a
line had been administered for CLAB and neonatal line-associated sepsis. SDHB should consider setting up DHB-wide reporting systems for HAI that include the collection, analysis, and reporting of information to committees that have the ability to ensure improvements and reduce patient harm. The role of the IPC team in this process should be clarified.

**Post-discharge surveillance**

A considerable amount of time and resources is dedicated to the collection of post-discharge caesarean wound infection surveillance. However, the expenditure of time and money may not be justified for one surgical procedure because the types of infections detected through post-discharge surveillance are mostly superficial and seldom associated with significant complication. The option of selecting a deep wound infection is provided on the post-discharge surveillance form. The deep infection must occur within 30 days after operation and involve deep soft tissue of the incision. The community midwife must additionally identify one of the four criteria for defining a deep incisional SSI: either on clinical diagnosis of a deep incisional SSI, abscess; or evidence of infection on direct examination, during reoperation or by histopathologic or radiological examination. The other two criteria rely on sign and symptoms: purulent drainage from deep incision and a deep incision spontaneously dehisces (ruptures), or deliberately opened by a surgeon, when patient has a fever or localised pain. The literature has shown that a system that quickly detects SSIs through simple indicators may be preferable (Avato and Lai, 2002). Such indicators could be hospital readmissions and procedures performed due to infection. This approach would require resources to implement but would identify deep and significant wound infections that the community midwives may not be able to detect without diagnosis by a surgeon or attending physician. Two of the deep incisional SSI criteria used by community midwives who report to Dunedin Hospital already rely on hospital personnel performing an examination. Documentation of a caesarean wound infection could then be made as part of clinical practice as well as for surveillance purposes. Appropriate forms or databases should be organised to allow ward staff to access and document required information.

**6.3.2.2 Numerator and denominator data collection**

The CDC have developed HAI surveillance forms for BSIs, MDRO and *C. difficile* infections, pneumonia, SSIs, and UTIs as part of the NHSN. To provide an example of the information
collected, the NHSN form for BSI surveillance is located in Appendix 6. The HAI surveillance forms include 4 pages of data collection; one page is dedicated to patient information, risk factors and event details involving signs and symptoms, laboratory information and clinical diagnosis. Two pages are allocated for information to be collected on the infecting pathogen. The infection control personnel collecting the information are able to select the infecting microorganism and mark the susceptible and resistant patterns for certain drugs. The fourth page allows for additional information and comments. The surveillance forms used in SDHB hospitals collected some of the same information but the forms vary in terms of the details provided and the presentation of information. The NHSN surveillance forms request more details concerning the pathogen and antimicrobials administered, with sensitivity and resistance noted. This is most likely linked to antimicrobial stewardship. The BSI forms used in Dunedin Hospital collects additional details on the patient’s underlying/predisposing medical conditions for BSI. In SDHB hospitals, there are no forms used for UTIs, pneumonia, and SSIs except for caesarean wound infections. The IPC team could develop forms based on the NHSN to help identify rates of infection and establish a surveillance programme. Both inpatient surveillance and post-discharge surveillance are carried out by the midwives in the Queen Mary Maternity ward. The surveillance form used to collect information concerning wound infection is similar to the SSI forms used in the NHSN. There is slightly more detail on the NHSN forms concerning signs and symptoms of infection as well as more information regarding the pathogen.

6.3.2.3 Evaluation characteristics of surveillance

As previously reported, the timeliness, accuracy, application, analyses, validity, acceptability and integration of the HAI surveillance system vary for each type of HAI and within each priority unit. This section reviews the key findings of the SDHB case study using the evaluation characteristics of the framework criteria.

The IPC team is notified of BSIs, MDROs and *C. difficile* infections by the microbiology lab as an infection occurs and data is subsequently reported to the infection prevention control committee. The information collected is not reported back to the clinical staff members where the information originated from, minimising the application of collected data. It is difficult for ward staff to keep track of their rates of BSIs, MDROs and *C. difficile* infection,
making it almost difficult to implement infection prevention and control actions to prevent HAIs.

The three-monthly review of caesarean wound infection data could be modified to monthly reviews and data could then be forwarded to relevant clinical staff. This would ensure infection control activities remain a focus within the unit and may result in reductions in wound infection. Caesarean wound infection data collection requires community midwives to observe and document the status of the patient, requiring time and resources. An extensive effort is made for the collection of data. However, the application of the data is minimal and the reporting of information does not occur in a timely manner. The three-monthly reviews and annual reporting means that a critical amount of time has passed before high or even low rates are identified and protocols put in place to prevent infections and to identify protocols that are working well.

SSI data from other surgical units is not routinely collected or reported; improvement in the surveillance of SSIs is regarded as a work in progress. The control of SSIs is a core element to many hospital infection prevention and control programmes. SSIs are the second most common type of HAI, attributing to significant cost to the healthcare system and associated with increased patient morbidity and mortality (Burke, 2003). Without routine monitoring of SSIs it is difficult to determine baseline infection rates and to prioritise resources effectively to minimise patient harm. The device-associated module of the NHSN is a critical component to the surveillance system and many hospitals in developed countries implement surveillance on SSIs including other New Zealand hospitals, as shown in the questionnaire results. However, the approach to SSIs in SDHB is fragmented and cumbersome. Hospital personnel from the surgical units or ideally the IPC team should discuss and establish the components of HAI surveillance. This involves the development of surveillance objectives, SSI definitions, surveillance methods including the potential uses of post-discharge surveillance and computer databases, the surveillance statistics and analysis to be generated and the possibility of benchmarking rates. Once the fundamentals have been established the system can be orientated to collect and apply data in a timely manner with consistent analysis and strong acceptability and integration.
CLAB data is continuously collected and reported monthly to stakeholders who then provide feedback. The surveillance programme for CLAB infections has strong acceptability and integration. Data collected from NICU are discussed in daily ward rounds and weekly department meetings. However, application of data outside of the wards is minimal. CLAB data is displayed in the ICU and routinely transferred for national collaboration. The utilisation of a national programme for infection control and surveillance, as seen with the CLAB Target Zero initiative allows surveillance to be performed in a timely and accurate manner, with strong acceptance, integration and application of information collected. Having an institution that is responsible for collating HAI information and providing feedback along with benchmarked results can facilitate local engagement in HAI surveillance and prevent infection.

The internationally recognised NHSN device-associated and procedure-associated modules involved HAI surveillance data collection performed by a trained infection control member. Many developed countries have adopted this approach to HAI surveillance in their own healthcare facilities. The surveillance of BSIs, MDROs and *C. difficile* infections are performed by the IPC team in conjunction with the microbiology laboratory. The priority units are taking ownership of the surveillance of CLAB infections, caesarean wound infections and neonatal line-associated sepsis infection data. It is important that this information is collected and reported. However, the literature highlights the need for trained infection prevention and control personnel to collect and report surveillance information. This would ensure HAI definitions, methods and analyses protocols are consistently applied with critical judgement to help achieve specified surveillance objectives. The accuracy and validity of the information collected and the analysis of the data may potentially be reduced without HAI surveillance data training for data collection.

6.3.3 National HAI surveillance questionnaire interpretations
6.3.3.1 Types of HAI monitored

The approach to HAI surveillance in New Zealand varies from each DHB hospital and for each type of HAI; this is also shown in the SDHB case study. With the exception of cUTIs and VAP, most hospitals surveyed performed surveillance of the investigated HAIs. The most common type of HAIs are cUTIs. Although VAPs are not as common as cUTIs and other HAIs, they are
associated with high mortality and cost. Many surveillance programmes implemented internationally, including the NHSN, incorporate the surveillance of VAP and cUTIs. SDHB hospitals and other DHB hospitals should consider investing resources into the surveillance of these infections at least in high priority areas such as ICUs.

The HAIGG survey conducted by the Ministry of Health was implemented around the same time as the survey from this study. Both surveys found that mixtures of manual and electronic systems are used for the surveillance of HAIs, with selected infections under surveillance. A nationally consistent approach to the data collection and reporting of HAIs was not found from either survey. The comments made in the HAIGG survey found that data collected is variable, cumbersome and probably not comparable. The HAIGG survey found that 74% of DHB hospitals perform surveillance of the following: (1) Hand Hygiene, (2) central line-associated bacteraemia, (3) surgical site infection, (4) blood stream infections, (5) multi resistant organisms, and (6) C. difficile (personal communication G. Storey, Ministry of Health 2013). Results from the questionnaire developed in this Master's thesis showed that all surveyed hospitals reported performing SSI surveillance and 86.7% of hospitals surveyed reported performing surveillance on C. difficile infections, showing higher reported participation in HAI surveillance programmes. However, the questionnaire developed for this research project obtained a 75% response rate from DHBs, whereas the HAIGG study obtained a 100% response rate. It is possible that hospitals that did not participate in the questionnaire developed for this Master's thesis may be less likely to perform HAI surveillance activities and therefore may have chosen not to take part in the survey.

6.3.3.2 Perceived strengths and weaknesses of the HAI surveillance performed
The HAI surveillance survey respondents agreed that the strengths of the current systems are: integration and communication with staff members and departments, information transfer to necessary personnel, the identification of mistakes and professional sensitivity with no punitive consequences directed at clinical staff. The main weaknesses identified by DHB hospitals are identical to the weaknesses experienced by SDHB hospitals. These weaknesses are: resource intensiveness of surveillance, the minimal medical staff involved in surveillance and the lack of an integrated database where HAI data can be logged. The
current approach to surveillance of HAIs in New Zealand varies within each major DHB hospital. Without a leading organisation for HAI surveillance data collection, analysis and dissemination it is difficult for hospitals to collaborate on surveillance initiatives and produce a national approach. The SSI national surveillance programme will provide DHB hospitals with the opportunity to perform coordinated surveillance on hip and knee SSIs. However, national approaches for the surveillance of other HAIs should also be considered.

6.3.3.3 Feedback/ dissemination of surveillance data
As previously stated, the dissemination of data is a fundamental component of an HAI surveillance system. The data collected should be disseminated to the people directly involved in patient care; medical personnel need to know the number of HAIs occurring or rates of infection. The reporting of infection rates to medical staff on wards, especially surgeons, is identified as a critical surveillance component. The dissemination of data should be organised through infection control teams and committees as they consist of personnel that have expertise in infection prevention and control and would be able to generate constructive feedback. An IPC team involved in HAI surveillance data reporting and reviewing was present in 80% of hospitals surveyed and an Infection Prevention and Control Committee or equivalent was present in 77.3%. This shows that groups for HAI surveillance data dissemination are established in most hospitals and have the ability to provide expertise and advice.

6.3.4 Evaluation of national HAI surveillance questionnaire using framework criteria
6.3.4.1 Surveillance methods
Currently the approaches to HAI surveillance in New Zealand DHB hospitals vary according to infections monitored, methods used, analysis performed and dissemination of data. Gaynes et al. (2001) highlights that a multicentre monitoring system must have a very clear purpose; it must use standard definitions, data fields, and protocols including cohorts or groups to be monitored and periods of data collection. There must also be an institution that provides standardised definitions and protocols, receives and collates data and assesses information for quality, standardises the surveillance approach for benchmarking, and interprets and disseminates the data. The CDC emphasises that infections monitored through the device-associated and procedure-associated modules which include CLAB, VAP and cUTI and SSIs
should be implemented in an active, patient-based, prospective manner (Centers for Disease Control and Prevention, 2006). Although the surveillance of CLAB infections, caesarean wound infections and neonatal line-associated sepsis infection is not performed by a member of the IPC team, it is implemented in an active, patient-based, prospective manner consistent with the CDC approach. The approach to denominator data collection varied for each DHB hospital and for each type of HAI. The NHSN system involves denominator data being collected by counting the cohort of patients at risk of acquiring an infection. This approach is performed for the surveillance of SSIs, but is uncommonly used for any other HAIs.

6.3.4.2 Evaluation characteristics of surveillance

For the majority of hospitals surveyed the timeliness of data collection and reporting for BSIs, SSIs, \textit{C. difficile}. and MDRO infections were perceived to be “good”. These hospitals mainly collect HAI surveillance data continuously and reporting the information monthly, indicating that infection control members have strong reflection of the surveillance performed. This approach is also consistent with the CDC’s (2006) description for active surveillance, facilitating prompt feedback of information which can be used for improving infection control activities.

The approach to HAI data reporting used by the NHSN and adopted by many countries is the calculation of risk adjusted infection rates, which accounts for differences in patient case mix. This allows for more meaningful comparisons between hospital personnel, surgeons or between hospitals, and enables inter-hospital comparison. Analyses of surveillance data was commonly described as “good” by questionnaire participants. Only one of these hospitals reported that rates of HAIs are calculated and controlled for variations in the distribution of major risk factors associated with HAI occurrence; most hospitals in this group identified calculating incidence rates. Before comparisons of infection rates are made between DHB hospitals, it is critical that infection control personnel are confident in calculating risk adjusted infection rates; otherwise comparisons are incompatible.
6.4 **Strengths and limitation of the study**

6.4.1 **Strengths of SDHB case study**

The high risk areas for HAIs were identified by the literature review as the surgical wards, including the maternity ward and adult and neonatal intensive care units. Representatives from Dunedin Hospital of all priority HAI areas were interviewed. A large representation of the IPC committee was also included in the interview process. These included members from the IPC team and representatives from microbiology, intravenous line therapies and infectious diseases.

The interviews were implemented on a one-on-one basis with the exception of two interviews as the participants believed that no new information would be provided by having separate interviews. I was an impartial interviewer with no affiliation to the hospital. Participants were free to discuss any issues and concerns regarding perceived strengths and weaknesses, with anonymity assured.

Once the audio recording of the interview was transcribed and summarised, a ‘thank-you’ email and a summary of the interview was sent to the corresponding participants to ensure that the information obtained was correct and not misleading. Informants were also given the opportunity to retract any statements or to provide additional information. It was evident while transcribing interviews that there were some inconsistencies regarding the reporting of HAI data collection. This was not due to misunderstandings but due to some participants not knowing where collected data is reported. The summary documents helped reduce these inconsistencies and allowed for clarification on issues which were unclear.

Consultation with SDHB study sponsors informed me of the hospital workings and external quality improvement programmes such as the Global Trigger Tools and Health Round Table. The study sponsors helped identify initial interview participants and facilitated my attendance to several hospital committee meetings in order to recruit relevant hospital personnel for interviewing. Having direct links with study sponsors may have also made the project more significant to participants.
6.4.2 Strengths of national HAI surveillance questionnaire

Even though comprehensive interviews had taken place with SDHB staff, the IPC charge nurse specialist of the major hospital in SDHB (Dunedin) completed a HAI surveillance questionnaire. This produced comparable data that had been consistently collected. The interview process provided a detailed account of the surveillance performed in SDHB hospitals and the questionnaire provided a description of the HAI surveillance performed in other DHB hospitals to allow for comparisons and review.

The questionnaire allowed participants to express any views on their approach to surveillance through free text spaces. The survey was split into eight key sections, with each section focusing on a specific HAI. Sections concerning HAIs that are not monitored by the participating hospital were able to be left unanswered making the questionnaire efficient and relevant to the participant.

A response rate of 75% was obtained from the national questionnaire, covering a range of hospitals in New Zealand that have access to different resources and are of different sizes in terms of beds and staff employed. This study tried to achieve a high response rate from the questionnaire by making initial contact with selected study participants through a telephone call. Background information and study objectives were described to the participant and clarification on any questions and concerns was provided.

6.4.3 Limitations of the Study

6.4.4 Limitations of SDHB Case Study

Initially 8 clinical personnel from the surgical areas were emailed with a request for interview participation. Interview times were made with 2 of the personnel; the other 6 clinical staff did not reply to messages. In the end only one interview took place. The other surgeon who had initially agreed to participate in the interview process was unfortunately called away to surgery at the time of our scheduled interview and subsequently did not reply to my email requesting to reschedule our interview. To increase the number of interviewees from the surgical areas, I consulted with the surgical service managers who provided me with the name and contact details of relevant surgeons who would be informed on the
surveillance performed. The service managers also contacted possible informants themselves to help gain interest. However, no additional interviews took place.

Emails were received from two additional clinical members from the surgical units. One email stated that they were unsure if there was any on-going SSI surveillance within their unit. The other email stated that IPC calculate HAI rates and the unit would not have any additional information to provide as often patients are discharged before the infection presents itself. Given that the practicing surgeons are limited with administration time, this is to be expected. Non-clinical surgical personnel were additionally interviewed to help gain representation from the surgical areas.

The study was conducted at the beginning of the SSI surveillance pilot phase (Health Quality & Safety Commission, 2013). Interviewees and questionnaire participants may have felt that they have already contributed enough information to this area, or that the issue is already being addressed. This made have altered their participation in the study. The case study involved interviews with SDHB hospital staff members. However, interviews were not carried out with Lakes District Hospital staff members. It was evident during the interview process that the Infection Control team situated in Southland Hospital covers Southland Hospital and Lakes District Hospital. All microbiology result from the laboratory is forwarded to the Infection Control team, who visit Lakes District Hospital every 6 to 8 weeks. The IC team subsequently report for Southland and Lakes District hospitals. Lakes District Hospital has an Infection Control Representative just the same as the clinical areas at Southland and Dunedin Hospital who are involved in infection control activities but not HAI surveillance. Therefore, it was determined unnecessary to burden Lakes District Hospital staff members as no new information concerning data collection and reporting would be generated. However, perceptions of strengths, weaknesses and required improvements may have been obtained in interviews were performed.

6.4.5 Limitations of national HAI surveillance questionnaire

The total number of hospitals participating in the HAI surveillance questionnaire was too small to produce statistically significant results. One representative from each DHB was selected to take part in the questionnaire; other members on the IPC team may have
elaborated different strengths and weaknesses. Furthermore, participation was only sought from major hospitals in each DHB area; surveillance performed in smaller DHB hospitals may be more or less comprehensive. However, the questionnaire recruitment process identified that the HAI surveillance in other smaller hospitals can be performed by the main DHB hospital in that area. It would have been an unnecessary burden to have the infection control nurse specialist completing several comprehensive questionnaires with the same information generated and a representation of one DHB hospital was a sufficient sample size for this Master’s thesis.

Data collected for this project is subjective in terms of perceptions and interpretations of terms and methods. Some infection control personnel may consider HAI surveillance to mean being notified on confirmed infections, whereas others may consider it to mean a comprehensive programme of monitoring and active intervention. The questionnaire was designed to determine the different components of surveillance used and for hospitals to identify all levels of surveillance performed. Definitions were adopted from the CDC and summarised for the term ‘healthcare acquired infection,’ and for each specific HAI type. These definitions were provided on the questionnaire to reduce ambiguity in terms.

The questionnaire was piloted to infection control personnel and to other non-hospital affiliated people to eliminate any unclear questions and to ensure complete understanding. However, during data entry and analysis it was evident that there was some ambiguity or confusion, or participants were limited with time as a few questions were unanswered instead of selecting “no”, “unsure”, or writing a comment regarding why the question was left unanswered. The questionnaire design allowed respondents to provide multiple answers to many questions which complicated the analysis. Furthermore, some respondents provided lengthy text responses; categorising these responses into meaningful groups was difficult and may have unintentionally excluded an important but infrequent response. A more in-depth analysis of the strengths and weakness identified by the participants in the free-text boxes would have provided a greater understanding in terms of improvement of HAI surveillance.
The questionnaire design may have further been limited by not asking the respondent to provide information about how long they had been in their stated infection prevention role, as some of the ‘unsure’ responses may be due to the respondent being new to their position.

This study provides a description of systems used for HAI surveillance. Specific data on rates of infection was not collected and public reporting on HAIs is controversial (see section 7.4.1). Additional permission from participants would have been required if rates of infection in each unit or overall hospital rates were obtained as participants may feel their unit is being judged or audited. Furthermore, this study found that data on certain HAIs is not collected. The validity of the surveillance performed cannot be determined as sensitivity and specificity with positive predicted values cannot be calculated without knowing the number of patients with an HAI.

6.4.6 Strength and weaknesses in relation to other studies

Very few studies analyse HAI surveillance systems through a descriptive approach. Studies look at the validity of the system in terms of sensitivity and specificity of the surveillance system to identify how accurate the known surveillance system is at identifying HAIs. Further studies should evaluate the surveillance systems implemented in DHB hospitals for the detection of HAIs. Questionnaires reviewing the HAI surveillance systems implemented in healthcare facilities have been performed. This section provides a discussion of two questionnaires reviewing the same or similar healthcare facilities as studied in this project.

The Australian healthcare facilities surveillance survey developed by ACSQHC was used to understand healthcare facilities demographics, staffing levels, surveillance activities, outcome, processes, technology, information systems and barriers. The questionnaire was delivered online from the 11th of December 2007 to January 2008. Infection control professionals responsible for the coordination of infection control and prevention programs were invited to take part in the survey. The questionnaire obtained feedback from a large sample with 278 participants including small facilities with less than 60 beds. Information regarding the surveillance of SSIs, BSIs, MDROs, *C. difficile* and surveillance performed in ICU and paediatric wards was collected. Questions were asked about specific surgical procedures
such as joint replacement surgery and lower segment caesarean sections (Cruickshank and Ferguson, 2008). The questionnaire developed for this Master’s thesis focused on certain hospital areas/units under surveillance, for example, orthopaedic units and maternity wards and specific infecting microorganisms that are under surveillance. Questions concerning specific surgical procedures would have been less ambiguous and would have provided a clear description of the surveillance performed. The questionnaire developed by Cruickshank and Ferguson (2008) was not piloted and although information regarding the barriers of performing surveillance was collected, perceived strengths were not investigated. Identifying perceived strengths would identify the systems or activities that are working strongly and would help generate recommendations.

The New Zealand HAIGG survey was distributed to all DHBs and obtained responses from all participants, providing a strong representation of the approach to HAI activities in New Zealand. The survey collected information concerning the capabilities of the infection prevention and control team, including information on the number of Full Time Equivalents (FTE) dedicated to infection prevention control, integration and links with medical microbiologists and infectious disease physicians, and the formal qualifications undertaken by the IPC team (personal communication G. Storey, Ministry of Health 2013). The number of FTE in the IPC team and links and integration with other infectious disease personnel may influence the surveillance priorities of the IPC team. However, questions concerning the specific methods used for data collection and analyses of each type of HAI were not obtained.

6.5 Implications of results

6.5.1 HAI surveillance in New Zealand

The study presented in this thesis has shown that currently there is no standard approach to HAI surveillance in New Zealand. The methods used for HAI surveillance and the infections monitored vary in each DHB hospital. The fragmented state of HAI surveillance in New Zealand means that HAI information is scarce, inconsistent, difficult to generalise and comparisons between hospitals are unattainable.
Countries with similar resources to New Zealand have established cohesive approaches to HAI surveillance. A national approach to HAI surveillance in New Zealand DHB hospitals is possible as resources and expertise are available. There are groups that are able to take action. However, the structure and organisation of such institutions may require rearrangement. National programmes should aid the initiation of surveillance in hospitals, but the infrastructure for efficient and effective surveillance should remain integrated within the hospital, allowing for continual surveillance, regardless of whether the programme is altered or suspended due to reforms.

The three initiatives under the Health Quality & Safety Commission provide the essential start to reducing the burden associated with HAI. It is important that acceptance and participation from clinical personnel is obtained as their willingness to engage in the programme is fundamental for success. HAI control and prevention programmes in the past have required hospitals to report information concerning infections. *S. aureus*-BSIs were previously reported to the Ministry of Health as part of key performance indicators. However, it was unclear to hospital personnel what the implications of the collected data were. The project was subsequently suspended with outcomes undocumented. Stakeholders must have trust in the programme and believe that programmes will be continued and outcomes generated. It was expressed in the interview process that hospital personnel find it frustrating to begin external governmental programmes, dedicating limited resources and time, only to have the projects suspended with outcomes unreported.

**SSI surveillance**

The HQSC’s SSI surveillance programme was anticipated for national roll-out in July 2013, but at the time of submitting this thesis the programme was awaiting implementation (Health Quality & Safety Commission, 2013). Understanding the current systems used in priority HAI areas and by IPC teams will allow the implementation of the national SSI programme to run efficiently with appropriate resource allocation when implemented in Dunedin Hospital. The SSI surveillance programme will include the ICNet software programme to track and report hip and knee SSIs. SSIs that are not associated with hip and knee procedures and other types of HAIs will not be followed under the national programme. HQSC does aim to subsequently include all SSIs in 3-5 years’ time (Health
Quality & Safety Commission, 2013). Lessons learnt from the New Zealand hand hygiene programme and CLAB programme have demonstrated that commitment is required from all hospital personnel (Roberts et al., 2012). Infection prevention and control is everyone's business and responsibility. The infection control members and clinical staff working on the hospital floor and the hospital CEOs and managers need to be serious about improving patient safety, and provide financial support for resources allowing for on-going commitment to infection control and surveillance programmes.

**MDROs and C. difficile infection**

Re-emerging infectious diseases are proving a challenge for infection prevention and control actions. Antimicrobial resistance contributes to poor patient outcomes and threatens the significant advances in treatment that have been made. *C. difficile* infection is a major cause of infectious diarrhoea among hospital patients. Outbreaks of *C. difficile* infection requires ward closures and extensive infection control measures, disrupting hospital process and impacting hospital finances and patient morbidity and mortality rates. Almost all *C. difficile* infections are associated with antibiotic use (Calfee, 2012). North America, Europe and Australia are experiencing an increased frequency and severity of *C. difficile* infection due to the emergence of virulent strains (Kuijper et al., 2006). Key principles for the prevention of MDROs and *C. difficile* infections involve surveillance and antibiotic stewardship. A specific module is dedicated for the surveillance of MDROs and *C. difficile* infection as part of the NHSN system. It is critical that New Zealand is prepared for the possible increase in MDROs and *C. difficile* infection. Continual data collection from DHB hospitals is important, along with the implementation of a standardised New Zealand approach.

**Other HAI surveillance**

The Health Roundtable (HRT) data, although limited by loose definitions and reliance on clinical staff to document infections correctly, offers an opportunity to obtain six-monthly HAI rates. Currently, in Southern DHB hospitals there is no routine data collection for VAP, cUTIs, and SSIs (other than caesarean wound infections) and only 20% and 33.3% of hospitals surveyed perform surveillance for VAP and cUTIs respectively. Data reported from the HRT would allow for internal hospital discussion and establishment of baseline infection rates. However, SSIs may be underestimated as patients are often discharged before
symptoms of infection appear and HAI events are only reported to the HRT through hospital patient coding charts. Furthermore, comparisons made between hospitals based on HRT data should also be interpreted with caution if risk adjusted rates are not calculated. As previously stated, the types of patients in each hospital differ and some may be at a higher risk due to the procedures performed and predisposing patient characteristics.

6.5.2 Benchmarking
The current varied approach to HAI surveillance makes hospital comparisons and benchmarking unattainable. Infection rates are highly dependent on the case-mix; e.g.- ICU/NICU patients have a higher risk of developing a CLAB. Month-to-month comparisons using crude rates between units within the same hospital is limiting, and internal hospital comparisons are even more difficult. There is a need to have some statistical analysis or a process chart with indicators to allow the detection of high rates of infections. Additionally, risk adjusted rates also provide an opportunity for internal and external hospital comparisons, which can be calculated by trained IPC personnel. Of the hospitals surveyed, only two were calculating risk adjusted HAI rates.

A critical component of benchmarking is the use of clearly defined, consistent, reproducible set of identifiers, allowing for the comparison of the rate of an event among facilities (Miller et al., 2006). Currently, the CLAB Target Zero national programme allows for external benchmarking between participating hospitals. External benchmarking between DHB hospitals for other HAIs is currently not attainable as there is no standardised approach to HAI data collection. The development of a national standardised HAI surveillance system whereby rates and trends of HAIs in DHB hospitals can be documented will allow for the establishment of appropriate benchmarks and assist hospitals in applying infection control interventions to reduce HAIs and ultimately improve patient care. Active support from DHBs and central government is likely to encourage hospitals to participate in such programmes.

6.5.3 Roles of hospital personnel in infection prevention and control
The lack of available resources is seen as a problem for IPC teams, in particular the number of people involved in control activities. Van den Broek et al. (2007) investigated the number of IPC staff needed for the delivery of infection control activities in a model hospital. The
study involved 16 experienced Dutch IPC practitioners and 10 medical microbiologists indicating how much time they would need to perform infection control activities in a hospital with 1370 beds, 280 000 nursing days per year, 39 000 admission and 40 intensive care beds. Participants agreed that a standard of one full-time equivalent infection control practitioner per 178 hospital beds and one FTE medical microbiologist per 806 hospital beds is recommended. The mean for surveillance activities for the infection control practitioner was 29.5 hours per week and 4 hours per week for the medical microbiologist (Van den Broek et al., 2007). Dunedin Hospital is a 388-bed tertiary facility and Southland Hospital is a 188-bed facility (Southern District Health Board, 2013); therefore following the guidelines developed by Van den Broek et al. (2007) the number of hospital beds per medical microbiologist is adequate in Dunedin hospital. Southland Hospital currently does not have a medical microbiologist. The microbiology lead in Southland hospital is involved in HAI surveillance activities and transfers laboratory infection information to the infection control team.

In DHB hospitals, the performance of HAI infection surveillance is usually carried out by an IPC nurse specialist or equivalent. The term Infection Control Practitioner is not defined in the article. However, the tasks carried out by such personnel are similar to those performed by the IPC team consisting of infection control nurse specialist in both Dunedin and Southland Hospitals who have 2.5 and 1.5 FTE in the IPC team respectively. Thus both Southland and Dunedin Hospital meet Van den Broek et al. (2007) recommendations. Consideration of the IPC team’s duties and prioritising and delegating certain tasks which do not require infection prevention and control professional may help reduce the workload burden experienced by the Dunedin Hospital’s IPC team.

6.5.6 Public reporting of HAI rates and health targets
The reduction of HAIs requires a response from hospital wards, hospital management and broader government committees. A policy response is influential, reforms in research and funding, training specifications and public reporting can have an effect on overall healthcare systems, leading to an impact on HAI rates.

The interview process identified the issue of public reporting of HAI rates. There are arguments in literature of inappropriate health targets and the pit falls of public reporting. It
can be seen as a punitive approach if rates of infection per surgeon are documented as there are other considerations to take into account for the high rates, e.g. they may be performing surgery on patients who have dirty wounds and traumas and is not indicative of poor technique. It was expressed in the interviews that surgeons will always try their best to avoid infections, but for some surgical procedures where traumatic injuries are involved, there will be higher contamination rates and in difficult and long surgeries there is also a higher risk of infection.

In England the public reporting of certain infections have had positive outcomes. The Health Protection Agency (HPA) implemented mandatory notification of MRSA-BSIs to reduce the rates of infection in 2001. This mandatory system allowed for a table of performance to be developed for the purpose of feedback. Hospitals with high rates of MRSA-BSIs were publicly identified, with the outcome that resources within those hospitals are made available to improve performance and ensure accountability for the problem (Health Protection Agency, 2013).

Public reporting of HAIs rates can restore public confidence. Public reporting in France began in 2006 with a focus on process indicators that assess infection control activities of healthcare facilities. The Netherlands decided that the PREZIES national surveillance data should not be publicly available as there was the risk that hospitals participating in the national programme would be at a disproportionate disadvantage compared with non-participating hospitals. McKibben et al. (2006) performed a systematic literature review to determine if public reporting systems improve healthcare performance and whether there was evidence of the effectiveness of confidential reporting systems in reducing HAIs. The investigators found that published studies do not provide strong support for the effectiveness of public reporting of HAI as a means to improve HAI prevention and control practices or to prevent the occurrence of HAI. The positive reductions seen in England are therefore likely to have been accomplished through improved infection control activities along with surveillance and not exclusively due to “ownership” of the problem.

Suetens et al. (2007) stated that there are two key considerations to take into account when considering mandatory public reporting: will the information mislead or confuse rather than
empower consumers? Will there be increased motivation for clinicians and hospital administrators to attend to HAI reduction, leading to safer care and fewer HAIs? Before such considerations are made it is fundamental that a national approach to surveillance is taken with a uniform surveillance protocol. Alongside these protocols, interpretation and understanding must be similar. Such standard protocols must first be established in New Zealand before consideration of public reporting is made (Suetens et al., 2007).

It is critical that the right policies are implemented in a positive manner; it is not enough to rely on good intentions. In USA, there are policies in place for HAI control and they have good intentions but unintended consequences. The Centers for Medicare and Medicaid will no longer pay hospitals for complications judged as preventable, including some HAIs (Rosenthal, 2007). This led to hospitals adopting unnecessary policies, such as taking cultures from the urinary catheters once the patient had been admitted to hospital in order to prove that the infection was not hospital acquired. These policies led to patients being prescribed more antibiotics for asymptomatic infections and staff began to hide data. It is important for hospital staff to work together to prevent infections and not direct blame. Encouraging a cooperative “team” culture is an important element in developing improvement processors and reporting events (Osmon et al., 2004).

6.5.4 Further research

Due to the need to identify the approach to HAI surveillance in SDHB hospitals and to establish recommendations based on other hospital settings, this study focused on HAI surveillance in hospital facilities. However, HAI surveillance encompasses all healthcare facilities including long-term acute care hospitals, psychiatric hospitals, rehabilitation hospitals, outpatient dialysis centres, ambulatory surgery centres, private hospitals and nursing homes. Results obtained from this study cannot be generalised for all healthcare facilities. Further research should be conducted to investigate the scope and extent of HAI surveillance in other facilities and to compare the difference between privately and publicly funded healthcare facilities.

Information dissemination and adequate engagement and feedback from clinical personnel have been identified as an important area for improvement through both the case study and
DHB questionnaire. Ensuring clinical engagement in infection prevention and control is not extensively investigated and more research is required to understand this area and provide possible solutions to produce effective engagement and communication channels. The HQSC’s SSI surveillance programme has been anticipated for national roll out. A review of the programme should be performed once the DHB have had enough time to implement the programme and generate information. The review will provide an understanding of the system, whether objectives have been met, or if there are any issues or concerns that need to be addressed.

6.6 Discussion summary
The systematic on-going collection, collation, and analysis of data and the timely dissemination of information to those who need to know is the first step in reducing the burden of HAIs. The HAI information dissemination has been identified as a weakness in SDHB hospitals. HAI data is collected by several hospital areas, and the overall approach is inconsistent with information disseminated in a fragmented manner. This makes it difficult to develop timely infection control actions for improvement and preventing HAIs. Surveillance requires the combined effort from clinical and managerial staff, and requires government support. At the time of this study there was no national approach to surveillance in New Zealand. The various methods used by DHB hospitals for HAI data collection and analysis restricts the comparability and generalisability of information produced. The national SSI surveillance programme will provide an essential start to a collaborative approach to HAI surveillance in New Zealand. Protocols regarding benchmarking, public reporting and the roles of infection control members will need to be considered.
7 Recommendations and Conclusions

7.1 Recommendations

This study has shown the strengths and limitations concerning the HAI surveillance performed in New Zealand. To help improve the surveillance performed in SDHB and in other DHB hospitals a series of recommendations have been established. These recommendations are based on literature review findings, the results obtained from SDHB interviews and the national HAI surveillance questionnaire.

7.1.1 Improve the prioritisation of HAI surveillance

All DHB hospitals should engage in HAI surveillance as it has been proven to reduce infection rates when information is fed back in a timely manner. Several high risk hospital areas in SDHB have taken ownership and are collecting and collating HAI data. A meeting between stakeholders from these hospitals and the infection control teams should be held to understand the needs of surveillance. The meeting should clarify who is performing surveillance, the infections that should be monitored, and how the information gathered will subsequently be transferred and disseminated.

7.1.2 Developing components of the HAI surveillance system

It has been shown that there is a lack of consistency in the information gathered in SDHB hospitals. The key components include the establishment of the objectives of HAI surveillance, definitions of each type of HAI and the methods used for data collection, reporting and analysis. The key components of the HAI surveillance system should be clearly reported and agreed upon so that there is consistency in the information obtained. This would create a systematic and explicit approach to surveillance within the hospital and would allow hospital personnel to easily recognise the surveillance approach used. A checklist of agreed upon criteria would make it clear to hospital personnel conducting surveillance what steps should be taken and the key elements that should be incorporated in the surveillance system.

7.1.3 Establishing and continuing links between DHB hospitals

The previously separate Southland and Otago DHBs have been merged in 2010 to create SDHB (SDHB 2013). In order to create a collaborative approach SDHB should consider setting
up DHB-wide reporting systems for HAI that include the collection, analysis, and reporting of information to committees that have the expertise in the area and ability to ensure improvements to reduce patient harm.

7.1.4 Surveillance of significant infections

Routine data collection for VAP, and cUTIs was not present in SDHB hospitals and only 20% and 33.3% of hospitals surveyed perform surveillance on these infections respectively. The literature has revealed that VAP and cUTIs are significant infections. UTIs associated with catheters are the most common type of HAI and VAP are associated with high mortality and financial cost. International HAI surveillance programme incorporate the surveillance of VAP and cUTIs. SDHB hospitals and other DHB hospitals should consider investing resources into the surveillance of these infections at least in high priority areas, such as ICUs. Internationally accepted NHSN surveillance methodology and concepts should be used.

7.1.5 Utilisation of current reports

DHB hospitals report externally to organisations that gather information for the Health Roundtable reports, the Global Trigger Tool programme and the Australian Indicator Report. Such reports are limited by loose definitions and reliance on clinical staff to document infections correctly. This type of reporting is not active surveillance; however, the reports offer an opportunity to obtain rates of all HAIs and assess the impact of HAIs in New Zealand with comparable rates. The external reports could initially be discussed in IPC committee meetings to help establish preliminary rates of infection and develop data collection and reporting systems in the identified priority areas.

7.1.6 Collaborative approach to HAI surveillance

The infection control team are an integral part of HAI surveillance; literature supports the notion of surveillance being performed by an infection control professional. Several hospital areas in SDHB implement their own surveillance of HAI as they have access to patient information and can communicate data readily within the department. The hospital areas should collaborate with the IPC team to help produce a systematic standard approach. The infection control team and committee offer expertise in infectious diseases and the control and prevention of infection, furthermore members have knowledge on epidemiology and surveillance protocols. A collaborative approach whereby HAI data is reported to the IPC
team in a timely manner with analysis and dissemination of data subsequently performed by the IPC team would allow for valid and reliable data.

7.1.7 Dissemination of surveillance data

Infection control teams should review how reporting of surveillance data to quality and risk managers and clinical staff could be improved. The lack of consistency and structure of the HAI information reporting highlights the need for organisation. Currently, clinical staff members are not receiving information in a timely manner. Figure 9 illustrates a simple layout of HAI reports that could potentially be used in SDHB hospitals. The high risk units are collecting and collating their own information on specific HAIs. This information is presented in a fragmented manner to the IPC team with minimal outcomes. The recommended approach would allow the high risk units to continue collecting their own data, but would facilitate more involvement from the IPC team. Trained infection control members are required to analyse and validate data. The collected HAI data should be distributed to the IPC team in a timely manner. This information should be analysed by the IPC team with rates determined and risk adjustments made. Subsequently, the IPC team could produce and present reports (similar to hospital-wide MDRO and BSI data) to the Infection Prevention Control Committee and Quality Improvement meetings. Feedback from these reports should be disseminated back to the clinical areas. If clinical personnel are unable to attend IPC committee meetings then it is critical that relevant information is distributed back to the clinical units. The literature review identified possible avenues for information feedback, this includes meeting minutes or summaries of information can be presented in graphic form on notice boards within the unit. However, ensuring adequate engagement from clinical staff should be on-going, not merely at the end with data presentation. Clinical staff should be consulted and engaged with in order to develop a system that works for all members involved in infection prevention and control.

7.1.8 Computer databases

The main weakness reported by SDHB personnel focus on the resource intensiveness of surveillance, and lack of technology. The utilisation of a computer database that is linked with the hospital departments including pharmacy, microbiology and radiology will help track infections and identify trends. Electronic systems have shown to significantly reduce resources needed to monitor HAIs. SDHB and other DHB hospital could utilise the ICNet
software programme to monitor all HAIs. Considerations regarding the utilisation of computer databases and software programmes should be discussed to help create an effective and efficient HAI surveillance by improving accuracy of HAI detection and reducing resources and time required to conduct HAI surveillance.
Dissemination of HAI reports back to clinical areas, along with feedback from committees, groups.

IPC Team

Surgical units
NICU
ICU
Queen Mary
Other wards

Infection Prevention Control Committee
Quality Improvement Committee, Education days, Clinical Board Meeting, Hospital Advisory Committee, Senior Management Group
Infection Prevention Quality meeting

Microbiology Lab

IPC could work with the high risk areas to collect HAI data in a timely manner.

Figure 9. Potential flow of HAI information within SDHB
7.2 Conclusions

HAIs are associated with prolonged hospital admissions, increases in morbidity and mortality rates and generate extensive additional burden to the healthcare system. Effective surveillance systems produce data to improve quality and patient care and provide the impetus for improvements.

The HAI priority areas within Dunedin Hospital collate surveillance data at varying frequencies and use their own approach. The reporting of surveillance data is also implemented in an ad hoc manner, with results from the different hospital areas communicating to various committees at different time periods. A systematic standard approach would allow for comparable data within the hospital. Southland Hospital has a similar method for HAI surveillance and informants have also noted the need for a systematic method for information collection and data feedback to clinicians and nurses. Clinical staff should receive periodic and timely reports on surveillance data and feedback on data should be collected in order to generate improvements.

A nationally consistent approach to the data collection and reporting of HAIs was not found. All DHB hospitals surveyed participate in the surveillance of BSIs, SSIs, and CLAB; data collection and reporting of VAP infections and cUTIs are minimal. The majority of hospitals surveyed successfully have an IPC team and a broader Infection Prevention and Control Committee, these internal groups are able to review and report surveillance information and provide critical support and expertise in infection control activities.

The three initiatives under the HQSQ provide the essential start to improving the quality care and safety of patients in hospital. It is important that the programmes are accepted by from clinical personnel as their willingness to engage in the programme is fundamental for success. Currently national systems are being implemented for the surveillance of hip and knee SSI, other HAISs are not yet followed on a national level making data scarce, inconsistent, and some HAIs may be missed. Recommendations for the improvement of HAI surveillance in DHB hospitals are provided in this thesis. These recommendations do not presume a solution to the overall impact of HAI in New Zealand; a combined effort from all areas in healthcare is required.
8 References


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9 Appendices

Appendix 1. Semi-structured Interview Questions

**General Interview Questions**

My project is about healthcare acquired infection surveillance. I'm defining HAI surveillance to mean any activities that contributes to the following areas:
- increasing sensitivity to infection control problems and identifying areas with possible infection control problems;
- obtaining confirmation of possible infection control problems;
- analysing reasons for infection control problems.
- and the feeding back of relevant info regarding HAs to clinical and managerial staff.

Surveillance as stated by WHO- is the on-going systematic collection, analysis, and interpretation of health data essential to the planning, implementation, and evaluation of practice, and the feeding back of relevant information to clinical and managerial staff.

**Name:**

**Job title and brief description:**

1. Could you please tell me about any systems or activities that you’re involved in that incorporate HAI surveillance?

2. Would you please describe the components of that system?

   - **What areas of the hospital are under surveillance?** (High risk units eg- ICU, hospital wide, certain surgical units?)
   - **What is the period of time of the data collection?**
   - **What data is collected and how is it collected?** (Are rates of HAI determined, patient information)
   - **What are the reporting sources of data for the system?** (Where is data coming from? How often is data collected? And then reported?)
   - **How are the system's data managed?** (Is information feeding back to clinical and managerial leaders?)
   - Are indicators of HAI being used? – laboratory, radio confirmation, radiology/imaging data
   - Post discharge surveillance- surgical site infections

3. What types of HAI are under surveillance?

   - (SSI, BSI, UTI, ventilator associated infections, resistant organisms?)
   - Continuous or in intervals surveillance
   - What’s the case definition for each specific condition, what definitions are being used for HAIIs are they adapted from the CDC definitions?

4. How is the information collected and stored?

   - Manually collected, databases used, software?
   - Is this system integrated with other activities (pharmacy, lab ect...) How well?

5. Are there any governmental policies for data collection or external reporting?
6. Describe the planned uses of the data from the system.
- How is the system's data analysed (Who and how) and disseminated? (How often)
- Who receives reports? (Groups and committees that receive data)

7. What do you like about your HAI surveillance system? Strengths

8. What do you believe needs changing of the HAI surveillance system? Weaknesses

9. Anything else that you would like to add?

10. Further interview participants- Is there anyone that you believe would add additional information and should be interviewed
Appendix 2. Information Sheet for SDHB Interviews

A REVIEW OF HEALTHCARE ACQUIRED INFECTION SURVEILLANCE IN DISTRICT HEALTH BOARD HOSPITALS
INFORMATION SHEET FOR PARTICIPANTS

Thank you for showing an interest in this project. Please read this information sheet carefully before deciding whether or not to participate. If you decide to participate we thank you. If you decide not to take part there will be no disadvantage to you and we thank you for considering our request.

What is the Aim of the Project?

The study aims to identify the systems currently used in Southern District Health Board (SDHB) hospitals for Healthcare acquired infection (HAI) surveillance of in-patients. International best practice for HAI surveillance will be determined via a literature review and recommendations for future HAI surveillance will also be provided. Key stakeholder interviews will be performed with clinical leaders and managers of SDHB hospitals and HAI surveillance in other DHB hospitals will be assessed through a survey. This project is being undertaken as part of the requirements for a Masters in Public Health. Kim Caffell, Nursing Director of SDHB Emergency/ Medicine and Diagnostic and Support (Otago site), and Chris Lovell-Smith, Medical Director of Diagnostic and Clinical Support (Otago site) are study sponsors for this project and Marion Poore, the Medical Officer from Public Health South will be a key facilitator of the project.

What Type of Participants are being sought?

This study seeks participants who are involved in the collection, analysis or interpretation of healthcare acquired infection data in district health board hospitals. Clinical leaders and service managers of SDHB hospitals will be identified by study sponsors and will be asked to partake in interviews. As a result of these interviews recommendations can be informed to improve surveillance of HAI resulting in shorter hospital stays, reduced morbidity and mortality rates and reduced hospital healthcare costs.

What will Participants be Ask Asked to Do?

Should you agree to take part in this project, you will be asked to answer a standard set of questions concerning HAI surveillance. Questions will be orientated to establish information regarding the systems used to monitor HAI, to determine what is done with their collected information, to identify perceived barriers and also what the directors believe needs be done with the current surveillance systems. Each interview will last around 40 minutes. Please be aware that you may decide not to take part in the project without any disadvantage to yourself of any kind

What Data or Information will be Collected and What Use will be Made of it?

A personal voice recorder will be used during interviews so that ideas arising from interviews can be analysed and described. A diagram of current information flow will be produced and the results from the interviews will aid in the development of recommendations for improvements in HAI surveillance. Personal information from the interview will include the job title of interviewees; this will be used to determine the surveillance systems used in different hospital departments.
The data collected will be securely stored in such a way that only those mentioned below will be able to gain access to it. At the end of the project any personal information will be destroyed immediately except that, as required by the University’s research policy, any raw data on which the results of the project depend will be retained in secure storage for five years, after which it will be destroyed. A final draft of the report will be circulated to contributors and interviewees will be given an opportunity to provide feedback.

The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand).

Due to the nature of the research it may be possible for people to determine who you are and it would also be preferable to attribute contributions made from participants. However, statements will not be directly attributed to you without your consent and if requested audio recording can be suspended.

Results from this study will be made available in the Otago University library and a report containing results will be provided to SDHB hospitals. You are also welcome to personally request a copy of the results from the researcher.

This project involves an open-questioning technique. The general line of questioning includes questions about healthcare acquired infection surveillance systems used in Southern District Health Board hospitals. The precise nature of the questions which will be asked have not been determined in advance, but will depend on the way in which the interview develops.

In the event that the line of questioning does develop in such a way that you feel hesitant or uncomfortable you are reminded of your right to decline to answer any particular question(s) and also that you may withdraw from the project at any stage without any disadvantage to yourself of any kind.

This proposal has been reviewed and approved by the Department of Preventive and Social Medicine, University of Otago.

**Can Participants Change their Mind and Withdraw from the Project?**

You may withdraw from participation in the project at any time and without any disadvantage to yourself of any kind.

**What if Participants have any Questions?**

Contact either:-

**Mahashweta Patel** and/or **Dr Patricia Priest**
Preventive and Social Medicine Preventive and Social Medicine
(03) 470-4646 (03) 479-7204
patma494@student.otago.ac.nz patricia.priest@otago.ac.nz

This study has ethical approval from by the Department stated above. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479-8256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.
Appendix 3. Consent Form for SDHB Interviews

A REVIEW OF HEALTHCARE ACQUIRED INFECTION SURVEILLANCE IN DISTRICT HEALTH BOARD HOSPITALS:
CONSENT FORM FOR PARTICIPANTS

I have read the Information Sheet concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.

I know that:

1. My participation in the project is entirely voluntary;

2. I am free to withdraw from the project at any time without any disadvantage;

3. Personal identifying information including audio-tapes will be destroyed at the conclusion of the project but any raw data on which the results of the project depend will be retained in secure storage for at least five years;

4. This project involves an open-questioning technique. The general line of questioning includes questions about healthcare acquired infection surveillance systems used in Southern District Health Board hospitals. The precise nature of the questions which will be asked have not been determined in advance, but will depend on the way in which the interview develops and that in the event that the line of questioning develops in such a way that I feel hesitant or uncomfortable I may decline to answer any particular question(s) and/or may withdraw from the project without any disadvantage of any kind

5. Statements will not be directly attributed to me without my consent and audio recording will be suspended if requested.

6. The results of the project may be published and available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve my anonymity.

I agree to take part in this

........................................................................................................  ........................................
(Signature of participant)  (Date)
Appendix 4. HAI Surveillance Questionnaire to DHB Hospitals

Questionnaire to Review Healthcare Acquired Infection Surveillance

A healthcare acquired infection (HAI) is an infection occurring in a patient in a hospital or other healthcare facility in whom the infection was not present or incubating at the time of admission.

Please answer all questions and mark the boxes as applicable. Comments can be made at the end of page two.

Date: / /2012

Name of hospital and DHB that you work for:

Please select your job title, or write a short description explaining your job:

□ Charge nurse manager, infection prevention and control (IPC)
□ Registered nurse, IPC
□ Team leader, IPC
□ Clinical nurse specialist, IPC
□ Infection Control advisor
□ Other:

1. Are the following types of HAIs monitored in your DHB hospital?

   Blood stream infections: No Yes, please complete Section A
   Surgical site Infections: No Yes, please complete Section B
   Central line associated bacteraemia: No Yes, please complete Section C
   Catheter associated urinary tract infection: No Yes, please complete Section D
   Multi drug resistant organisms: No Yes, please complete Section E
   Ventilator associated pneumonia: No Yes, please complete Section F
   Clostridium difficile: No Yes, please complete Section G

2. Are there any other HAIs that are monitored within your DHB hospital which have not been identified in Q1?
   □ No
   Yes, please specify the type of HAI and the hospital units or areas where they are monitored

3. Once HAI surveillance data has been collected, how is the information analysed? Mark all that apply.

   □ Rates of HAI are calculated for all patients overall.
   □ Rates of HAIs are calculated and are controlled for variations in the distribution of major risk factors associated with HAI occurrence.
   □ The incidence rate is calculated by dividing the number of new HAIs occurring during a given period by the number of patients at risk of acquiring an HAI during the period.
   □ Prevalence is calculated using all patients who are being treated with an HAI at the time of data collection.
   Other approaches, please describe:

4. How is the surveillance information stored? Please provide a brief explanation

   □ Paper based method
   □ Electronic (Access, Excel or other)
   Other, please describe:

5. Do you have an Infection Prevention and Control Team? How many people of the following are in it?

   □ Clinical nurse specialist □ Microbiologist □ Infectious Disease Physician □ Data managers/analyst
   Other:
6. Which of the following teams/committees exist in your organisation to review and report HAI surveillance data? More than one answer can be selected per question

☐ The infection prevention and control (IPC) team ☐ The IPC Committee ☐ The Antibiotic committee
☐ The Quality Improvement Committee ☐ The Clinical board groups
☐ Departmental meetings - relevant HAI data is fed back to medical staff and discussed in-house

Other stakeholder groups or approaches for the reporting of HAI surveillance data:

7. How well do you rate your current HAI surveillance system on each of the following criteria? Mark with an x

<table>
<thead>
<tr>
<th>The timeliness of collecting and reporting surveillance data</th>
<th>Excellent</th>
<th>Very good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Not applicable/not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>The validity of data collected</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accuracy and completeness of numerator and denominator data</td>
<td></td>
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<tr>
<td>The application of HAI surveillance data collected</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>The analyses of HAI surveillance data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. What do you believe are some of the strengths of your current surveillance system? Mark all that apply.

☐ Good integration and communication with staff members and departments
☐ There is a simplified method for data collection, analysis and reporting
☐ Information is transferred to the necessary personnel
☐ Identifies where mistakes are occurring and suggests improvements
☐ Professional sensitivity, there is no blame directed to clinicians and nursing staff

Other:

9. What do you believe are some of the weaknesses of your current surveillance system? Mark all that apply.

☐ The absence of surveillance for some HAIs ☐ The need for local HAI targets and benchmarks
☐ The system is resource intensive ☐ Poor engagement from staff for data collection
☐ Minimal medical staff involved in surveillance ☐ Poor feedback on HAI information to clinical staff
☐ The absence of standard definitions, criteria and protocols for HAI surveillance
☐ The absence of a systematic reporting system for HAIs, that is central including data presentation
☐ The need for an integrated database where HAIs can be logged

Other:

10. If you like to make any further comments, please write them in the space below.


SECTION A: Blood stream Infections (BSIs)

The definition of BSIs includes: a pathogen cultured from one or more blood cultures that is not related to an infection at another site; signs or symptoms such as fever, chills, or hypotension.

1. Please select the areas of the hospital that are under surveillance for BSIs. Mark all that apply.
   - [ ] Unsure
   - [ ] Hospital wide
   - [ ] Intensive care unit (ICU)
   - [ ] Neonatal ICU
   - [ ] Maternity ward
   - [ ] All surgical units
   Specific surgical units, please state: ____________________________
   Other wards: ____________________________

2. Please identify the infecting microorganism(s) that are under surveillance for BSIs. Mark all that apply.
   - [ ] All BSIs
   - [ ] BSI-Staphlococcus
   - [ ] BSI-Staph aureus
   - [ ] BSI-MRSA
   - [ ] BSI-E.coli
   - [ ] BSI-Klebsiella
   Other BSIs: ____________________________

3. How often is BSI surveillance data collected and reported?
   Collected: [ ] Continuously  [ ] Daily  [ ] Weekly  [ ] Monthly  [ ] Annually  [ ] Other: ____________________________
   Reported:  [ ] Continuously  [ ] Daily  [ ] Weekly  [ ] Monthly  [ ] Annually  [ ] Data not reported
   Other: ____________________________

Please answer the following questions to identify the surveillance method used for collecting data on BSIs in your hospital. Comments can be made in the space provided.

4. Patients are monitored by observation for the development of a BSI during their hospitalisation. Infection prevention and control (IPC) personnel screen relevant reports and discuss with medical staff possible BSI cases?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   Comment: ____________________________

5. The BSI is identified via chart reviews after patient discharge?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   Comment: ____________________________

6. Personnel who do not have a primary surveillance role (ward nurses, doctors or therapists) identify and report the BSI to IPC personnel?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   Comment: ____________________________

7. Microbiologist notifies the IPC personnel on BSI cases?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   Comment: ____________________________

8. BSI surveillance is targeted at patients undergoing specific medical procedures or at a risk of developing an BSI?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   Comment: ____________________________

9. Surveillance data is only evaluated when the number of isolates of a particular species or number of positive blood cultures exceed an outbreak threshold?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   Comment: ____________________________

10. Denominator data for calculating rates of infection is collect by counting the cohort of patients at risk of acquiring a BSI?
    - [ ] Yes
    - [ ] No
    - [ ] Unsure
    Comment: ____________________________

Question 11 and 12 relate to how surveillance data for BSI is reported in your hospital.

11. The IPC team, documents monthly infection rates for BSIs and creates graphs/charts?
    - [ ] Yes
    - [ ] No
    - [ ] Unsure
    Comment: ____________________________

12. A report is produced and presented to the IPC Committee, or to an equivalent group, regarding infection rates for BSIs?
    - [ ] Yes
    - [ ] No
    - [ ] Unsure
    Comment: ____________________________
SECTION B:

Surgical site infections (SSI)

SSIs include superficial incisional SSI, deep incisional SSI and organ/space SSI, the infections occur within 30 days after the operation.

1. Please select the areas of the hospital that are under surveillance for SSIs. Mark all that apply.
   - Unsere
   - All surgical units
   - Maternity ward (caesarean-SSI)
   - Orthopaedic unit
   - General surgery
   - Selected procedures or surgical wards, please specify:

2. Please identify the infecting microorganism(s) that are under surveillance for SSIs. Mark all that apply
   - All SSIs
   - SSI-Staphilococcus
   - SSI-Staph aureus
   - SSI-MRSA
   - SSI-Enterococcus
   - SSI-E.coli
   - SSI-Candida albicans
   - Other SSIs:

3. How often is SSI surveillance data collected and reported?
   - Collected: Continuously Daily Weekly Monthly Annually Other:
   - Reported: Continuously Daily Weekly Monthly Annually Data not reported

Please answer the following questions to identify the surveillance method used or collecting data on SSIs, in your hospital for SSIs. Comments can be made in the space provided.

4. Surgical patients are monitored by observation for the development of a SSI during their hospitalisation. Infection prevention and control (IPC) personnel screen relevant reports e.g.- patient notes, microbiology reports and discuss with medical staff possible SSI cases?
   - Yes
   - No
   - Unsure
   - Comment:

5. SSI surveillance is targeted at patients undergoing specific surgical procedures or at a risk of developing a SSI?
   - Yes
   - No
   - Unsure
   - Comment:

6. SSIs are identified through post discharge surveillance through a follow-up phone call, questionnaire or notification from a GP?
   - Yes
   - No
   - Unsure
   - Comment:

7. Personnel who do not have a primary surveillance role (ward nurses, doctors or therapists) identify and report the SSI to IPC personnel?
   - Yes
   - No
   - Unsure
   - Comment:

8. Microbiologist notifies the IPC personnel on SSI cases?
   - Yes
   - No
   - Unsure
   - Comment:

9. Surveillance data is only evaluated when the number of isolates of a particular species or number of positive cultures exceed an outbreak threshold?
   - Yes
   - No
   - Unsure
   - Comment:

10. Denominator data is obtained by infection prevention and control personal collecting data from operating room logs and patient charts. Also, information on selected operative procedures are recorded eg-type of procedure, date and risk factors.
    - Yes
    - No
    - Unsure
    - Comment:

Question 11 and 12 relate to how surveillance data for SSI is reported in your hospital

11. The IPC team, documents monthly infection rates for the SSI and creates graphs/charts?
    - Yes
    - No
    - Unsure
    - Comment:

12. A report is produced and presented to the IPC Committee, or to an equivalent group, regarding infection rates for the SSI?
    - Yes
    - No
    - Unsure
    - Comment:
SECTION C:

Central line associated bacteremia (CLAB) infections

CLAB are BSIs where the patient had a central line in place at the time of, or within 48 hours before the onset of the event.

1. Please select the areas of the hospital that are under surveillance for CLAB. Mark all that apply.
   - [ ] Unsure
   - [ ] Hospital wide
   - [ ] ICU
   - [ ] Neonatal ICU
   - [ ] Maternity ward
   Other: ____________________________

2. Please identify the infecting microorganism(s) that are under surveillance for CLAB infections. Mark all that apply.
   - [ ] All CLAB
   - [ ] CLAB-Staphlococcus
   - [ ] CLAB-Staph aureus
   - [ ] CLAB-MRSA
   - [ ] CLAB-E.coli
   - [ ] CLAB-Klebsiella
   - [ ] CLAB-Enterococcus
   - Other CLAB: ______________________

3. How often is CLAB infection surveillance data collected and reported?
   Collected: ____________________
   - [ ] Continuously
   - [ ] Daily
   - [ ] Weekly
   - [ ] Monthly
   - [ ] Annually
   Other: ____________________________
   Reported: ________________________
   - [ ] Continuously
   - [ ] Daily
   - [ ] Weekly
   - [ ] Monthly
   - [ ] Annually
   Data not reported

Please answer the following questions to identify the surveillance method used for collecting data on CLAB infections in your hospital.

4. Patients are monitored by repeat observation for the development of a CLAB infection during their hospitalisation. Infection prevention and control (IPC) personnel screen relevant reports and discusses with medical staff possible CLAB cases?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   Comment: _______________________

5. CLAB infections are identified via chart reviews after patient discharge?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   Comment: _______________________

6. CLAB surveillance is targeted at patients undergoing specific procedures or at a risk of developing a CLAB infection?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   Comment: _______________________

7. Personnel who do not have a primary surveillance role (ward nurses, doctors or therapists) identify and report the CLAB infection to IPC personnel?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   Comment: _______________________

8. Microbiologist notifies the IPC personnel on CLAB cases?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   Comment: _______________________

9. Surveillance data is only evaluated when the number of isolates of a particular species or number of positive blood cultures exceed an outbreak threshold?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   Comment: _______________________

10. Denominator data is collected by infection prevention and control personal recording daily counts of the number of patients admitted and the number of patients with an administered central line?
    - [ ] Yes
    - [ ] No
    - [ ] Unsure
    Comment: _______________________

Question 11 and 12 relate to how surveillance data for CLAB infections is reported in your hospital.

11. The IPC team, documents monthly infection rates for CLAB infections and creates graphs/charts?
    - [ ] Yes
    - [ ] No
    - [ ] Unsure
    Comment: _______________________

12. A report is produced and presented to the IPC Committee, or to an equivalent group, regarding infection rates for CLAB infection?
    - [ ] Yes
    - [ ] No
    - [ ] Unsure
    Comment: _______________________
SECTION D: Catheter associated urinary tract infections (cUTIs)

UTIs that are catheter-associated relate to patients with an indwelling urinary catheter at the time or within 48 hours before onset of the event. There is no minimum period of time that the catheter must be in place in order for the UTI to be considered catheter-associated.

1. Please select the areas of the hospital that are under surveillance for cUTIs. Mark all that apply.
   - [ ] Unsure
   - [ ] Hospital wide
   - [ ] ICU
   - [ ] Neonatal ICU
   - [ ] Maternity ward
   - [ ] All surgical units
   - Specific surgical units: ____________________________
   - [ ] Other units: ____________________________

2. Please identify the infecting microorganism(s) that are under surveillance for cUTIs? Mark all that apply.
   - [ ] All cUTIs
   - [ ] cUTI- E.coli
   - [ ] cUTI-Klebsiella
   - [ ] cUTI-Enterobacter
   - [ ] cUTI-Pseudomona
   - [ ] cUTI- Staphilococcus
   - Other cUTIs: ____________________________

3. How often is cUTIs surveillance data collected and reported?
   - Collected: ____________________________
   - [ ] Continuously
   - [ ] Daily
   - [ ] Weekly
   - [ ] Monthly
   - [ ] Annually
   - [ ] Other: ____________________________
   - Reported: ____________________________
   - [ ] Continuously
   - [ ] Daily
   - [ ] Weekly
   - [ ] Monthly
   - [ ] Annually
   - [ ] Other: ____________________________
   - Data not reported

Please answer the following questions to identify the surveillance method used for collecting data on cUTIs, in your hospital.

4. Patients are monitored by observation for the development of a cUTI during their hospitalisation. Infection prevention and control (IPC) personnel screen relevant reports and discuss with medical staff possible cUTI cases?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   - Comment: ____________________________

5. cUTIs are identified via chart reviews after patient discharge?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   - Comment: ____________________________

6. cUTI surveillance is aimed at patients undergoing specific procedures or at a risk of developing a cUTI?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   - Comment: ____________________________

7. Personnel who do not have a primary surveillance role (ward nurses, doctors or therapists) identify and report cUTIs to IPC personnel?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   - Comment: ____________________________

8. Microbiologist notifies the IPC personnel on cUTI cases?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   - Comment: ____________________________

9. Surveillance data is only evaluated when the number of isolates of a particular species or number of positive cultures exceed an outbreak threshold?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   - Comment: ____________________________

10. Denominator data is collected by infection prevention and control personal recording daily counts of the number of patients admitted and the number of patients with an administered catheter?
    - [ ] Yes
    - [ ] No
    - [ ] Unsure
    - Comment: ____________________________

Question 11 and 12 relate to how surveillance data for cUTI is reported in your hospital.

11. The IPC team, documents monthly infection rates for cUTIs and creates graphs/charts?
    - [ ] Yes
    - [ ] No
    - [ ] Unsure
    - Comment: ____________________________

12. A report is produced and presented to the IPC Committee, or to an equivalent group, regarding infection rates for cUTIs?
    - [ ] Yes
    - [ ] No
    - [ ] Unsure
    - Comment: ____________________________
SECTION E: Multi drug resistant organisms (MDROS)

MDROS are defined by the CDC as a microorganism that is resistant to one or more classes of antimicrobial agents.

1. Please select the areas of the hospital that are under surveillance for MDROS. Mark all that apply.
   - Unsure
   - Hospital wide
   - ICU
   - Neonatal ICU
   - Maternity ward
   - All surgical units
   - Specific surgical units: ________________________________
   - Other units: ________________________________

2. Please identify the infecting microorganism(s) that are under surveillance for MDROS. Mark all that apply.
   - All MDROS
   - Multi drug resistant Staph aureus
   - Extended Spectrum Beta-Lactamases
   - Vancomycin-Resistant Enterococci
   - Klebsiella pneumonia producing carbapenems
   - Other MDROS: ________________________________

3. How often is MDRO surveillance data collected and reported?
   - Collected: Continuously
   - Daily
   - Weekly
   - Monthly
   - Annually
   - Other: ________________________________
   - Reported: Continuously
   - Daily
   - Weekly
   - Monthly
   - Annually
   - Data not reported

   Please answer the following questions to identify the surveillance method used for collecting data on MDROS, in your hospital. Comments can be made in the space provided.

4. Patients are monitored by repeat observation for the development of a MDRO infection during their hospitalisation. Infection prevention and control (IPC) personnel screen relevant reports and discusses with medical staff possible MDRO cases?
   - Yes
   - No
   - Unsure
   - Comment: ________________________________

5. The MDRO is identified via chart reviews after patient discharge?
   - Yes
   - No
   - Unsure
   - Comment: ________________________________

6. Personnel who do not have a primary surveillance role (ward nurses, doctors or therapists) identify and report the MDRO to IPC personnel?
   - Yes
   - No
   - Unsure
   - Comment: ________________________________

7. Microbiologist notifies the IPC personnel on MDRO cases?
   - Yes
   - No
   - Unsure
   - Comment: ________________________________

8. BSI surveillance is targeted at patients undergoing specific medical procedures or at a risk of developing MDRO?
   - Yes
   - No
   - Unsure
   - Comment: ________________________________

9. Surveillance data is only evaluated when the number of isolates of a particular species or number of positive cultures exceed an outbreak threshold?
   - Yes
   - No
   - Unsure
   - Comment: ________________________________

10. Denominator data is collect by counting the cohort of patients at risk of acquiring a MDRO?
    - Yes
    - No
    - Unsure
    - Comment: ________________________________

   Question 11 and 12 relate to how surveillance data for MDROS is reported in your hospital.

11. The IPC team, documents monthly infection rates for MDROS and creates graphs/charts?
    - Yes
    - No
    - Unsure
    - Comment: ________________________________

12. A report is produced and presented to the IPC Committee, or to an equivalent group, regarding infection rates for MDROS?
    - Yes
    - No
    - Unsure
    - Comment: ________________________________
SECTION F: Ventilator associated pneumonia (VAP)

VAP is identified using a combination of radiological, clinical and laboratory criteria. The patient must be intubated and ventilated at the time of, or within 48 hours before the onset of the event. There is no minimum period of time that the ventilator must be in place for the pneumonia to be considered ventilator associated.

1. Please select the areas of the hospital that are under surveillance for VAP. Mark all that apply.
   - [ ] Unsure
   - [ ] Hospital wide
   - [ ] ICU
   - [ ] Neonatal ICU
   - [ ] Maternity ward
   - [ ] All surgical units

Specific surgical units: ____________________________

Other units: ____________________________

2. How often is VAP surveillance data collected and reported for VAP? Mark all that apply.
   - [ ] Collected: Continuously
   - [ ] Daily
   - [ ] Weekly
   - [ ] Monthly
   - [ ] Annually
   - [ ] Other: ____________________________

   - [ ] Reported: Continuously
   - [ ] Daily
   - [ ] Weekly
   - [ ] Monthly
   - [ ] Annually
   - [ ] Data not reported

Please answer the following questions to identify the surveillance method used for collecting data on VAP in your hospital. Comments can be made in the space provided.

3. Patients are monitored by repeat observation for the development of a VAP during their hospitalisation. Infection prevention and control (IPC) personnel screens relevant reports and discusses with medical staff possible VAP cases?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   - Comment: ____________________________

4. VAP cases are identified via chart reviews after patient discharge?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   - Comment: ____________________________

5. VAP surveillance is aimed at patients undergoing specific procedures or at a risk of developing VAP?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   - Comment: ____________________________

6. Personnel who do not have a primary surveillance role (ward nurses, doctors or therapists) identify and report VAP to IPC personnel?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   - Comment: ____________________________

7. Microbiologist notifies the IPC personnel on VAP cases?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   - Comment: ____________________________

8. Surveillance data is only evaluated when the number of isolates of a particular species or number of positive cultures exceed an outbreak threshold?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   - Comment: ____________________________

9. Denominator data is collected by infection prevention and control personal recording daily counts of the number of patients admitted and the number of patients with an administered ventilator?
   - [ ] Yes
   - [ ] No
   - [ ] Unsure
   - Comment: ____________________________

Question 10 and 11 relate to how surveillance data for VAP is reported in your hospital.

10. The IPC team, documents monthly infection rates for VAP and creates graphs/charts?
    - [ ] Yes
    - [ ] No
    - [ ] Unsure
    - Comment: ____________________________

11. A report is produced and presented to the IPC Committee, or to an equivalent group, regarding infection rates for VAP?
    - [ ] Yes
    - [ ] No
    - [ ] Unsure
    - Comment: ____________________________
SECTION 6:

Clostridium difficile

*Clostridium difficile* infection is defined as the presence of symptoms (usually diarrhoea) and either a stool test positive for *C. difficile* toxins or toxigenic *C. difficile*, or colonscopic or histopathologic findings.

1. Please select the areas of the hospital that are under surveillance for *C. difficile*. Mark all that apply.

- Unsure
- Hospital wide
- ICU
- Neonatal ICU
- Maternity ward
- All surgical units
- Specific surgical units:
- Other units:

2. How often is *C. difficile* surveillance data collected and reported?

<table>
<thead>
<tr>
<th>Collected:</th>
<th>Continuously</th>
<th>Daily</th>
<th>Weekly</th>
<th>Monthly</th>
<th>Annually</th>
<th>Data not reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported:</td>
<td>Continuously</td>
<td>Daily</td>
<td>Weekly</td>
<td>Monthly</td>
<td>Annually</td>
<td>Data not reported</td>
</tr>
</tbody>
</table>

Please answer the following questions to identify the surveillance method used for collecting data on *C. difficile* in your hospital. Comments can be made in the space provided.

3. Patients are monitored by repeat observation for the development of *C. difficile* during their hospitalisation. Infection prevention and control (IPC) personnel screen relevant reports and discuss with medical staff possible *C. difficile* cases?

- Yes
- No
- Unsure

Comment:

4. *C. difficile* infections are identified via chart reviews after patient discharge?

- Yes
- No
- Unsure

Comment:

5. Personnel who do not have a primary surveillance role (ward nurses, doctors or therapists) identify and report *C. difficile* cases?

- Yes
- No
- Unsure

Comment:

6. Microbiologist notifies the IPC personnel on *C. difficile* cases?

- Yes
- No
- Unsure

Comment:

7. BSI surveillance is aimed at patients undergoing specific medical procedures or at a risk of developing *C. difficile*?

- Yes
- No
- Unsure

Comment:

8. Surveillance data is only evaluated when the number of isolates of a particular species or number of positive cultures exceed an outbreak threshold?

- Yes
- No
- Unsure

Comment:

9. Denominator data for calculating infection rates is collect by counting the cohort of patients at risk of acquiring *C. difficile*?

- Yes
- No
- Unsure

Comment:

Question 10 and 11 relate to how surveillance data for *C. difficile* is reported in your hospital.

10. The IPC team, documents monthly infection rates of *C. difficile* and creates graphs/charts?

- Yes
- No
- Unsure

Comment:

11. A report is produced and presented to the IPC Committee, or to an equivalent group, regarding infection rates of *C. difficile*?

- Yes
- No
- Unsure

Comment:
Appendix 5. Information Sheet for HAI Surveillance Questionnaire

A REVIEW OF HEALTHCARE ACQUIRED INFECTION SURVEILLANCE IN DISTRICT HEALTH BOARD HOSPITALS INFORMATION SHEET FOR PARTICIPANTS

Thank you for showing an interest in this project. Please read this information sheet carefully before deciding whether or not to participate. If you decide to participate we thank you. If you decide not to take part there will be no disadvantage to you and we thank you for considering our request.

What is the Aim of the Project?
The study aims to identify the systems currently used in District Health Board (DHB) hospitals for healthcare acquired infection (HAI) surveillance of in-patients. This project is being undertaken as part of the requirements for a Masters in Public Health.

Who is being asked to take part?
Infection prevention and control staff in each DHB are being sent the attached questionnaire. It can be completed by someone who has an overview of the collection, analysis or interpretation of healthcare acquired infection data in the DHB’s hospitals.

What Data or Information will be Collected and What Use will be Made of it?
The questionnaire asks about the systems used to monitor HAIs, what is done with collected data, perceived barriers, and suggested improvements to existing surveillance systems. The questionnaire itself will take around 10 minutes to complete, if you have all the information at hand.

The information obtained from the questionnaire will be reviewed and analysed by those mentioned overleaf. Analyses will aggregate the information, and individual DHBs or participants will not be identified. Due to the nature of the research, particular information obtained from the questionnaire may need to be mentioned for the improvement of surveillance systems. Every attempt will be made to ensure that it is not possible for readers to determine who you are, and no attribution of comments by participants will be made.
The results from this study will aid in the development of recommendations for improvements in HAI surveillance. Personal information on the questionnaire will include only the job title and the name of the hospital or DHB that the answers apply to.

The data collected will be securely stored in such a way that only the researcher and supervisors mentioned below will be able to gain access to it. At the end of the project any personal information will be destroyed immediately except that, as required by the University's research policy, any raw data on which the results of the project depend will be retained in secure storage for five years, after which it will be destroyed.

Results from this study will be made available in the Otago University library (Dunedin) and a report including aggregated, anonymised results from the survey will be provided to participating DHBs and submitted for publication in a peer reviewed journal. You are also welcome to request a personal copy of the results from the researcher.

This proposal has been reviewed and approved by the Department of Preventive and Social Medicine, University of Otago.

What if Participants have any Questions?
If you have any questions about this project, either now or in the future, please feel free to contact either:-

Mahashweta Patel and/or Dr Patricia Priest
Preventive and Social Medicine Preventive and Social Medicine
(03) 470-4646 (03) 479-7204
patma494@student.otago.ac.nz patricia.priest@otago.ac.nz

This study has ethical approval from by the Department stated above. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479-8256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.
Appendix 6. Frequency Tables

Table 20. Frequency of BSI surveillance data collection and reporting compared to self-perceived timeliness

<table>
<thead>
<tr>
<th>Self-perceived timeliness (number of hospitals selecting criteria)</th>
<th>BSI collected continuously</th>
<th>BSI collected weekly</th>
<th>BSI collected monthly</th>
<th>BSI collected annually</th>
<th>BSI reported weekly</th>
<th>BSI reported monthly</th>
<th>BSI reported annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent (1)</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Very Good (3)</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Good (6)</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Fair (5)</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Poor (0)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>1</td>
<td>1</td>
<td>11</td>
<td>1</td>
</tr>
</tbody>
</table>

NB: Values may not add to the total number of participants performing the type of HAI surveillance as participants may have selected more than one type of frequency for data collection or reporting, or may not have selected a frequency of data collection or reporting.

Table 21. Frequency of SSI surveillance data collection and reporting compared to self-perceived timeliness

<table>
<thead>
<tr>
<th>Self-perceived timeliness</th>
<th>SSI collected continuously</th>
<th>SSI collected weekly</th>
<th>SSI collected monthly</th>
<th>SSI collected annually</th>
<th>SSI reported continuously</th>
<th>SSI reported monthly</th>
<th>SSI reported annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent (1)</td>
<td>1</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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</tr>
<tr>
<td>Very Good (3)</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Good (6)</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Fair (5)</td>
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<td>1</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Poor (0)</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total (15)</td>
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<td>1</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>10</td>
<td>3</td>
</tr>
</tbody>
</table>

NB: Values may not add to the total number of participants performing the type of HAI surveillance as participants may have selected more than one type of frequency for data collection or reporting, or may not have selected a frequency of data collection or reporting.
Table 22. Frequency of cUTIs surveillance data collection and reporting compared to self-perceived timeliness

<table>
<thead>
<tr>
<th>Self-perceived timeliness (number of hospitals selecting criteria)</th>
<th>cUTI collected continuously</th>
<th>cUTIs collected daily</th>
<th>cUTIs reported daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent (1)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Very Good (3)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Good (6)</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fair (5)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Poor (0)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total (15)</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 23. Frequency of CLAB surveillance data collection compared to self-perceived timeliness

<table>
<thead>
<tr>
<th>Self-perceived timeliness</th>
<th>CLAB collected continuously</th>
<th>CLAB collected daily</th>
<th>CLAB collected weekly</th>
<th>CLAB collected monthly</th>
<th>CLAB collected annually</th>
<th>CLAB reported continuously</th>
<th>CLAB reported weekly</th>
<th>CLAB reported monthly</th>
<th>CLAB reported annually</th>
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<td>Excellent (1)</td>
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<td>0</td>
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<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Very Good (3)</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
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<td>1</td>
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<td>10</td>
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</table>
### Table 24. Frequency of VAP surveillance data collection and reporting compared to self-perceived timeliness

<table>
<thead>
<tr>
<th>Self-perceived timeliness (number of hospitals selecting criteria)</th>
<th>VAP collected continuously</th>
<th>VAP reported monthly</th>
</tr>
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<tbody>
<tr>
<td>Excellent (1)</td>
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<tr>
<td><strong>Total (15)</strong></td>
<td><strong>3</strong></td>
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### Table 25. Frequency of MDRO surveillance data collection and reporting compared to self-perceived timeliness

<table>
<thead>
<tr>
<th>Self-perceived timeliness</th>
<th>MDRO collected continuously</th>
<th>MDRO collected weekly</th>
<th>MDRO collected monthly</th>
<th>MRDO reported continuously</th>
<th>MDRO reported monthly</th>
<th>MDRO reported annually</th>
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<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Very Good (3)</td>
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<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Good (6)</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Fair (5)</td>
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<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Poor (0)</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td><strong>Total</strong></td>
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<td><strong>2</strong></td>
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<td><strong>8</strong></td>
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Table 26. Frequency of *C. difficile* surveillance data collection and reporting compared to self- perceived timeliness

<table>
<thead>
<tr>
<th>Self- perceived timeliness (number of hospitals selecting criteria)</th>
<th><em>C. difficile</em> collected continuously</th>
<th><em>C. difficile</em> collected weekly</th>
<th><em>C. difficile</em> collected monthly</th>
<th><em>C. difficile</em> reported continuously</th>
<th><em>C. difficile</em> reported monthly</th>
<th><em>C. difficile</em> reported annually</th>
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<td>1</td>
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<tr>
<td>Very Good (3)</td>
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<td>0</td>
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<tr>
<td>Good (6)</td>
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<td>4</td>
<td>1</td>
</tr>
<tr>
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<td>1</td>
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<tr>
<td>Poor (0)</td>
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<td><strong>12</strong></td>
<td><strong>1</strong></td>
<td><strong>1</strong></td>
<td><strong>3</strong></td>
<td><strong>8</strong></td>
<td><strong>2</strong></td>
</tr>
</tbody>
</table>

Table 27. Self-perceived rating of the application of HAI surveillance data and the different groups that review and report data

<table>
<thead>
<tr>
<th>Self-perceived application of surveillance data (number of hospitals selecting criteria)</th>
<th>IPC team</th>
<th>IPC Committee</th>
<th>Quality Improvement committee</th>
<th>Clinical board Meetings</th>
<th>Department meetings where data originated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent (0)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Very Good (4)</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Good (6)</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Fair (3)</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Poor (2)</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total (15)</strong></td>
<td><strong>12</strong></td>
<td><strong>11</strong></td>
<td><strong>8</strong></td>
<td><strong>8</strong></td>
<td><strong>8</strong></td>
</tr>
</tbody>
</table>
Table 28. Self-perceived rating of analysis of HAI surveillance data and the different methods of analyses performed

<table>
<thead>
<tr>
<th>Self-perceived analysis rating (number of hospitals selecting criteria)</th>
<th>Overall rates calculated</th>
<th>Controlled rates</th>
<th>Incidence rates</th>
<th>Prevalence rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent (1)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Very Good (3)</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Good (6)</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Fair (4)</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Poor (1)</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total (15)</td>
<td>9</td>
<td>2</td>
<td>7</td>
<td>2</td>
</tr>
</tbody>
</table>
Appendix 7. CDC Surveillance Forms

Primary Bloodstream Infection (BSI)

**Required for saving. Required for completion.**

<table>
<thead>
<tr>
<th>Event ID</th>
<th>Event ID</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Patient ID:</em></td>
<td>Social Security #:</td>
</tr>
<tr>
<td>Secondary ID:</td>
<td>Medicare #:</td>
</tr>
<tr>
<td>Patient Name: First:</td>
<td>Middle:</td>
</tr>
<tr>
<td><em>Gender:</em></td>
<td><em>Date of Birth:</em></td>
</tr>
<tr>
<td><em>Ethnicity (Specify):</em></td>
<td><em>Race (Specify):</em></td>
</tr>
<tr>
<td><em>Event Type:</em></td>
<td><em>Date of Event:</em></td>
</tr>
</tbody>
</table>

Post-procedure BSI: Yes No

Date of Procedure: ____________

**MDRO Infection Surveillance:**
- [ ] Yes, this infection's pathogen & location are in-plan for Infection Surveillance in the MDRO/CDC Module
- [ ] No, this infection's pathogen & location are not in-plan for Infection Surveillance in the MDRO/CDC Module

**Date Admitted to Facility:**

**Location:**

**Risk Factors:**

- [ ] If ICU/Other locations, Central line: Yes No
- [ ] If Specialty Care Area, Permanent central line: Yes No
- [ ] Temporary central line: Yes No
- [ ] *If NICU, Central line, including umbilical catheter:* Yes No

**Birth weight (grams):**

**Event Details**

- [ ] *Specific Event: Laboratory-confirmed*
- [ ] *Specify Criteria Used: Signs & Symptoms (check all that apply)*

**Any Patient:**

- [ ] Fever
- [ ] Chills
- [ ] Hypotension
- [ ] Bradycardia

**1 year old:**

- [ ] Laboratory (check one)

**Common commensal from ≤ 2 blood cultures**

**Pathogen #**

**Pathogen #**

**Pathogen #**

**Gram-positive Organisms**

- [ ] Staphylococcus coagulate-negative
  - [ ] Identified

- [ ] Enterococcus spp. (specify):
  - [ ] AMP SIRN SIRN
  - [ ] CIPROLEVO/FOXMOX SIRN
  - [ ] TETRA SIRN SIRN
  - [ ] DOXYMMINO SIRN SIRN
  - [ ] PENYMELIN SIRN SIRN
  - [ ] LINZ SIRN SIRN

- [ ] Enterococcus faecium
  - [ ] AMP SIRN SIRN
  - [ ] CIPROLEVO/FOXMOX SIRN
  - [ ] TETRA SIRN SIRN
  - [ ] DOXYMMINO SIRN SIRN
  - [ ] PENYMELIN SIRN SIRN
  - [ ] LINZ SIRN SIRN

**Gram-negative Organisms**

- [ ] Acinetobacter spp. (specify):
  - [ ] AMK SIRN SIRN
  - [ ] AMP SIRN SIRN
  - [ ] AZT SIRN SIRN
  - [ ] CEFP SIRN SIRN
  - [ ] CEFTAZ SIRN SIRN
  - [ ] CIPROLEVO SIRN SIRN
  - [ ] COLP SIRN SIRN

- [ ] Escherichia coli
  - [ ] AMK SIRN SIRN
  - [ ] AMP SIRN SIRN
  - [ ] CEFTRIAX SIRN SIRN
  - [ ] CIPROLEVO SIRN SIRN
  - [ ] TETRA SIRN SIRN

- [ ] Enterobacter spp. (specify):
  - [ ] AMK SIRN SIRN
  - [ ] AMP SIRN SIRN
  - [ ] CIPROLEVO/FOXMOX SIRN
  - [ ] TETRA SIRN SIRN

- [ ] Klebsiella spp. (specify):
  - [ ] AMK SIRN SIRN
  - [ ] AMP SIRN SIRN

---

**Discharge Date**: ____________

**BSI Contributed to Death**: Yes No

**- Died**: Yes No

**- If Yes, specify on pages 2-3**

**Pathogens Identified**: Yes No

**Public reporting burden of this collection of information is estimated to average 50 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a currently valid OMB control number.**

**Please consult the text for additional information.**

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### Primary Bloodstream Infection (BSI)

#### Gram-negative Organisms (continued)

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>AMK</th>
<th>AMP</th>
<th>AMPSUL/IMXCLV</th>
<th>AXT</th>
<th>CEFAZ</th>
<th>CESEP</th>
<th>CETOTIC/EPTX</th>
<th>CTET</th>
<th>CHLOR</th>
<th>CIPRO/LEVO/MIKI</th>
<th>COL/PS</th>
<th>ERM</th>
<th>GENT</th>
<th>IMP</th>
<th>MEMO/DORI</th>
<th>PPTAZ</th>
<th>TETRA/DOXY/MINO</th>
<th>TGA</th>
<th>TMZ</th>
<th>TOBRA</th>
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</thead>
<tbody>
<tr>
<td><em>Serratia marcescens</em></td>
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<tr>
<td><em>Pseudomonas aeruginosa</em></td>
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<tr>
<td><em>Sternotrophomonas</em></td>
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</table>

#### Fungal Organisms

<table>
<thead>
<tr>
<th>Specified: Candida spp.</th>
<th>AND</th>
<th>CASPO</th>
<th>FLUCO</th>
<th>FLUCY</th>
<th>ITRA</th>
<th>MICA</th>
<th>VORI</th>
<th>SODON</th>
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<tr>
<td></td>
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</tbody>
</table>

#### Other Organisms

<table>
<thead>
<tr>
<th>Organism 1 (specify)</th>
<th>Drug 1</th>
<th>Drug 2</th>
<th>Drug 3</th>
<th>Drug 4</th>
<th>Drug 5</th>
<th>Drug 6</th>
<th>Drug 7</th>
<th>Drug 8</th>
<th>Drug 9</th>
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<tbody>
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</table>

<table>
<thead>
<tr>
<th>Organism 1 (specify)</th>
<th>Drug 1</th>
<th>Drug 2</th>
<th>Drug 3</th>
<th>Drug 4</th>
<th>Drug 5</th>
<th>Drug 6</th>
<th>Drug 7</th>
<th>Drug 8</th>
<th>Drug 9</th>
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</thead>
<tbody>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Organism 1 (specify)</th>
<th>Drug 1</th>
<th>Drug 2</th>
<th>Drug 3</th>
<th>Drug 4</th>
<th>Drug 5</th>
<th>Drug 6</th>
<th>Drug 7</th>
<th>Drug 8</th>
<th>Drug 9</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>SIRN</td>
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<td>SIRN</td>
<td>SIRN</td>
</tr>
</tbody>
</table>

### Result Codes

1 = Susceptible, 2 = Intermediate, R = Resistant, NS = Non-susceptible, S/CD = Susceptible/dose dependent, N = Not tested

### Drug Codes:

- **AMK** = amikacin
- **AMP** = ampicillin
- **AMPSUL** = ampicillin/sulbactam
- **AMCL** = amoxicillin/clavulanate
- **CHLOR** = chloramphenicol
- **ERTAZ** = ceftazidime
- **CEFAZ** = cefazolin
- **CEFEP** = cefepime
- **CEFOT** = cefotaxime
- **CEFTRX** = ceftriaxone
- **CFTR PIX** = cefixime
- **CIPRO** = ciprofloxacin
- **LEVO** = levofloxacin
- **LEVOR** = levorotaxine
- **MICA** = micacin
- **MEMO** = memdamycin
- **MEMO/DORI** = demdamycin
- **MON</script>