A Discussion of the Issues surrounding the Design of an Effective Infectious Disease Surveillance System which meets the Needs of all Users in an Irish Hospital Setting.

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Dedication

This thesis is dedicated in its entirety to our baby boy,

Tiarnán Brabazon Carton

Declaration

I declare that the work described in this dissertation is, except where otherwise stated, entirely my own work, and has not been submitted as an exercise for a degree at this or any other university.

Signed: _____

Mícheál W. Carton

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Mícheál W. Carton

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Abbreviations:

EHO: Environmental Health Officer
VRE: Vancomycin Resistant *Enterococci*
NHO: National Hospitals Office
STI: Sexually Transmitted Infection
LIMS: Laboratory Information Management System
CAWT: Co-operation And Working Together
CIDR: Computerised Infectious Disease Reporting
SARI: Strategy for the Control of Antimicrobial Reisistance in Ireland
HPSC: Health Protection Surveillance Centre
CLSI: Clinical Laboratory Standards Institute
HSE: Health Service Executive
MRSA: Methicillin Resistant *Staphylococcus aureus*
AMR: Anti-microbial Resistance

Summary

Background:
In todays healthcare paradigm, infectious disease surveillance forms a key component of service delivery. Its importance in the hospital setting in Ireland has been recognised by the fact that over the past decade, a number of personnel have been put in place in Irish hospitals to facilitate surveillance in this environment. These staff include: surveillance scientists, anti-microbial pharmacists and infection control nurses. These professionals represent a skill set tailored to conduct such surveillance activities as antibiotic stewardship, reporting antimicrobial resistance rates and introducing interventions to prevent and control the spread of infectious disease. Typically these professionals would work closely with consultant microbiologists, usually through infection control teams, to ensure that surveillance activities result in appropriate and timely actions being taken.

Aim:
The aim of this thesis is to investigate the issues around the design of a comprehensive and effective infectious surveillance system to meet the needs of all users at an organisational level in an Irish hospital setting.

Methodology: A comprehensive literature review of national nosocomial surveillance systems was presented. This review compared three main national surveillance systems in relation to surgical site infection surveillance, intensive care unit surveillance and bloodstream infection surveillance. In addition, a needs assessment was performed in order to ascertain the surveillance needs of users and stakeholders at a hospital level. This assessment was carried out by means of a series of over thirty semi-structured interviews. Finally data collected in the interviews were used to design a surveillance system structure within the hospital setting.

Discussion and Conclusions: The literature review presented in this thesis gives a detailed description of how national nosocomial surveillance is conducted in other jurisdictions. In the coming years, it is likely that these types of surveillance will become part of the hospital surveillance landscape in Ireland. Therefore, this literature review provides an opportunity for hospitals to begin planning these future surveillance initiatives now.

In addition, the results of a series of semi-structured interviews were presented. The information gathered during this process was used to set surveillance priorities within the hospital setting. Furthermore, the methodology used may be adapted for use in other hospitals wishing to carry out a similar survey. Finally, a proposal for a hospital surveillance system structure was presented based on the findings of the needs assessment. It is hoped that these surveillance structures will provide the hospital setting with a scalable solution for conducting hospital-based surveillance for the foreseeable future.

Chapter 1

1.1 Introduction

Infectious disease surveillance is an important and complex discipline. Its purpose is to provide information on trends and patterns of infectious disease incidence to a number of professional groups. These groups include those at the forefront of delivering medical care (medical practitioners, nursing staff), allied health professionals (scientists, pharmacists) and decision makers (hospital management, regional and national management structures and national centres of excellence). This information may be used in a number of important processes including monitoring infectious diseases, evaluation of the effectiveness of interventions and informing policy.

1.2 Motivation

This thesis presents an investigation of the issues surrounding the design and implementation of an effective surveillance system in an Irish hospital setting. An effective surveillance system should provide enough information for all potential users of the system so that appropriate control measures and policies can be put in place to ensure a high quality of patient care is maintained. Although there are few national hospital surveillance projects in Ireland, this area is rapidly developing. For example, laboratories participate in surveillance initiatives such as bacteraemia surveillance, pharmacies may participate in antibiotic consumption surveillance and some accident and emergency departments participate in sentinel surveillance initiatives such as emergency respiratory admissions. At a hospital level, while individual departments may be involved in such surveillance initiatives, the links between different departments within the same hospital are often not well developed. As a result, repetition and duplication of work can be a problem. Furthermore, in the absence of a unified surveillance structure within the hospital, communication of important surveillance information can often be sub-optimal. Therefore an opportunity exists to streamline surveillance activities so that the maximum benefit is gained from surveillance both locally and nationally.

1.3 Research Question

This thesis investigates and discusses issues surrounding the design of an effective infectious disease hospital surveillance system, which meets the needs of all users in an Irish hospital setting.

1.4 Methods

In order to answer the research question posed in this thesis, three distinct bodies of work are described, each of which employs a different methodology. Firstly, a comprehensive literature survey was carried out to describe the 'state of the art' in terms of nosocomial surveillance internationally. This literature review collates information from a number of sources including the peer-reviewed literature and guidelines on national nosocomial surveillance from other jurisdictions. Secondly, a series of over thirty semi-structured interviews were conducted in an Irish hospital setting in order to identify the needs of users and stakeholders in terms of surveillance information. This needs assessment identified specifically the types of surveillance information stakeholders required as well as how surveillance information should be disseminated in order that appropriate action be taken. Finally, it was demonstrated how the information gathered in the literature review and the needs assessment could be applied in a specific Irish hospital setting. This was achieved by analysing all data inputs and outputs to the surveillance system and using this information to propose an effective hospital surveillance system structure.

1.5 Contributions

The literature review carried out as part of this thesis will be of benefit to any hospital considering formalising the surveillance structures in place or indeed, where a new system is to be developed. In light of the fact that basic ICU surveillance and bloodstream infection surveillance are already being collected at a national level, it is important to ensure that all local hospital surveillance systems can accommodate an expanding set of surveillance initiatives at a national level.

The needs assessment described in this thesis is the first of its kind in Ireland. Not only has it provided valuable information for the hospital setting where the interviews were conducted, but the methodology can be adapted by other hospitals who may wish to perform a similar exercise.

Finally, the surveillance system structure put forward in this thesis could be used as a template for other hospitals in Ireland. In the hospital setting where the study took place, a report with the main findings of this thesis and a proposal for formalising surveillance structures within the hospital, is to be submitted to hospital management and the hospital infection control committee for consideration.

1.6 Thesis Outline

Chapter 2 presents an introduction to the discipline of surveillance and provides background information on the origins of surveillance, basic principles and current issues of relevance to hospital surveillance. Much of the terminology used throughout this thesis is also introduced in Chapter 2.

A comprehensive literature review, focusing on national nosocomial surveillance system documentation from other jurisdictions is provided in Chapter 3. This chapter also compares three commonly used nosocomial surveillance systems; bloodstream infection (BSI) surveillance, Intensive Care Unit (ICU) surveillance and Surgical Site Infection (SSI) surveillance.

Chapter 4 summarises the results of a surveillance system needs assessment that was conducted in an acute hospital setting in Ireland. This needs assessment comprised a series of over thirty semi-structured interviews with a range of professional groups within the hospital and community settings.

Using data from Chapters 3 and 4, Chapter 5 presents a proposal for a hospital surveillance system structure that meets the needs of all users and stakeholders. This chapter briefly describes the main inputs and outputs of this system. Finally, the thesis concludes with Chapter 6, where lessons learned and a number of key points identified in this thesis are discussed.

Chapter 2

2.1 Introduction

This chapter will discuss some of the basic concepts in infectious disease surveillance and describe some of the main issues surrounding surveillance in the hospital setting.

2.2 Disease surveillance:

Many definitions of surveillance have been published. One of the most quoted definitions is from the US Centres for Disease Control (CDC) Principals of Epidemiology Manual (2006): "The ongoing systematic collection and analysis of data and the provision of information which leads to action being taken to prevent and control a disease, usually one of an infectious nature."

2.3 Surveillance Loop:

It is clear from the disease surveillance definition that there are three strands to surveillance:

- Data collection
- Data analysis
- Reporting of information for action

These components of disease surveillance are often described as the surveillance loop, reflecting the cyclical nature of surveillance. Those from whom data are collected should be fed back analysis so that appropriate action can be taken.

2.4 Early Historical Records of Surveillance Applications

Of course, human disease is a complex interaction between host and pathogen. As early as 400BC Hippocrates had suggested that both host and environmental factors could influence the progression of disease. This theory was not conclusively tested until the separate work of two physicians, namely Ignaz Semmelweis and John Snow. Ignaz Semmelweis, an obstetrician in Vienna General Hospital in 1840, noticed that 20% of women on one particular ward died soon after birth with "childbed fever" (Colyer, 2003). It transpired that some of the obstetricians between deliveries were also performing autopsies and Semmelweis hypothesised that the infection was spread from the autopsy room to the delivery room by microscopic particles (Noakes et al., 2007). Semmelweis instigated a strict handwashing regime with chlorinated lime

water and immediately mortality rates dropped. Although he had strong evidence, his theories were dismissed by his peers. Fourteen years later, in 1854, John Snow a physician in London began an investigation of a severe cholera outbreak in London. He was convinced that the outbreak was due to "microscopic morbid matter or particles" in contaminated water (Newsom, 2006). In all, within a matter of days, 83 deaths occurred within a 250-yard radius of Broadstreet. Snow mapped the address of the deaths and water pumps in the area. One pump was located almost at the centre of the epidemic and further investigation discovered people drinking from other pumps in the area were unaffected by cholera. Soon after, the handle of the contaminated pump was removed and the outbreak dissipated. This investigation is considered one of the first cases of field epidemiology which had considerable public health implications and also began a new branch of science.

Soon after the insightful works of Semmelweis and Snow, in 1862, the doctrine of spontaneous generation (that life could spontaneous arise from organic matter) was replaced by Louis Pasteur's "germ theory of disease". Since then there have been numerous significant advances in the field of microbiology and surveillance, including the publication of the first bacterial genomic sequence (*Haemophilus influenza*) in 1995 (Fleischmann et al., 1995), the introduction of molecular diagnostics in the clinical setting and the elucidation of anti-microbial resistance mechanisms.

2.5 Types of Surveillance

Collecting infectious disease surveillance data has a number of specific objectives including the ongoing monitoring of disease trends with public health action in mind, to gain knowledge on the natural progression of infectious disease and to make available information and baseline data as required. Not all data on cases of infection can be collected, however, due to the principal of confidentiality. Therefore, specific "notifiable" infections have been identified by law, so that public health professionals can monitor them (infectious disease regulations SI 707 for 2003). Finally, other datasets may be collected where there is "a clear overriding duty to society" (Declich & Carter, 1994). In these instances, the following principals should be adhered to in order to ensure the quality of the surveillance data gathered:

1. that there is a clear motivation for collecting the data

2. that only the required information for surveillance purposes is gathered,
3. that the data is "easy" to collect,
4. that there is a standard method for data collection (e.g. standard surveillance forms),
5. that standard case definitions for each disease are available,
6. that the data is gathered in a timely manner and
7. that the dataset is as complete as possible.

Finally, use of the correct method of surveillance for the purpose required is essential. The various types of surveillance that can be carried out include passive surveillance, active surveillance, sentinel surveillance, secondary data analysis surveillance and special surveillance surveys/investigations.

Passive Surveillance

Passive surveillance as it suggests is an inert type of surveillance in that it is dependent on data providers to produce the information and send it to the relevant authority. An example of this type of system is the National Notification Surveillance System. In this system all, clinicians and directors of laboratories are legally obliged to notify the local medical officer of health of any notifiable disease or outbreak. In this way the system is "waiting" on the data providers to notify the infectious disease event. The advantage of this system is that there is little effort expended in data collection however, the serious drawback is that often there is a high level of under-reporting for specific diseases.

Active Surveillance

Active surveillance involves active searching for new cases of an infectious disease or the input of extra effort to collect data, confirm diagnoses and identify risk factors. This type of surveillance is extremely important in the context of outbreaks where primary case contacts are investigated for any sign of the infectious disease, for example contacts of patients with TB or meningitis are always followed up and offered testing and/or prophylaxis as required. This public health action is also known as "Contact Tracing". Active surveillance however, is expensive in terms of clinical time and therefore is only carried out for certain infectious diseases.

Sentinel Surveillance

Sentinel Surveillance requires a limited and committed group of data providers to supply all data available on a prearranged list of infectious diseases. Generally the data providers, usually clinicians will be selected based on their patient cohort being representative of the general population. In other words, the infectious disease trends for this sentinel surveillance population should closely follow the trend in infectious diseases in the general population. This type of system can provide an early warning for infectious disease epidemics.

Secondary data Surveillance

Particular datasets already available to health agencies are becoming increasingly frequently used to monitor or detect infectious disease incidents. In Ireland an example of a dataset which can be used for secondary data surveillance is the Hospital In-Patient Enquiry System maintained by the Economic and Social Research Institute. This system was designed to quantify the casemix and workload of Irish hospitals and provides clinical information (ICD-9 and ICD-10 coded) on each admission to hospital. Although this type of analysis can provide valuable information on the historical progression of disease, lack of timeliness, missing data and misclassification of events are common problems.

Surveillance Surveys

Occasionally, specially designed surveillance surveys are carried out to answer specific questions about the incidence, trends or local responses to certain infectious diseases. Some Irish examples of specialised surveillance surveys include, the "North/South Study of MRSA in Ireland 1999", "Acute Gastro-enteritis in Ireland North and South – a Telephone Survey (2003)" and "Prevalence Survey of Healthcare Associated Infection in Ireland 2006".

2.6 Surveillance Analysis, Interpretation & Dissemination

The work of Semmelweis and Snow demonstrated some of the basic concepts in epidemiology and surveillance. First, appropriate data must be collected, suitable analysis performed and then action can be taken. Thus, with the successful collection of surveillance data by the appropriate method comes the responsibility to analyse, interpret and disseminate any findings to both data providers and other interested

parties. Surveillance data analysis primarily assesses "time, place and person" (Declich & Carter, 1994). These particular parameters are paramount in considering infectious disease trends. In time analysis, it is important to identify secular trends (long term upward or downward trends), cyclic trends (e.g. 3 year trends), seasonal trends and epidemic or outbreak trends. In place analysis, the geographical location of the patient at disease onset may be important in order to determine the risk of exposure to the local population. Also, determining the source of an infection, e.g. a contaminated water supply may provide information for further action. In person analysis, the characteristics of a group of patients (age, gender, nationality, immunity and socio-economic status) with a particular disease may identify risk factors for the disease. In other words, surveillance data analysis provides knowledge or information for further interpretation. This interpretation exercise may include consideration of improvements in diagnostic capabilities, changes in population size, and changes in reporting patterns. It is important to assess if any infectious disease trends uncovered during data analysis are reflecting the true real-world situation or is due to an artefact in the surveillance system itself. Dissemination of information or interpreted data to "those who need to know" is a fundamental and necessary requirement of infectious disease surveillance. Often the distribution of information takes the format of an e-mail bulletin, monthly national newsletter (e.g. Epi-Insight), or annual report. Furthermore, national agencies with a remit for infectious disease surveillance generally have a dedicated website for providing up-to-date infectious disease information and access to historical data and publications.

2.7 Developments in Surveillance in Ireland

In Ireland, several important developments in surveillance at a national level are noteworthy. In 1996, the Health Protection Surveillance Centre (formerly the National Disease Surveillance Centre) was formed. This agency acts as the national centre for collating and reporting on incidence of mandatory notifiable diseases, the majority of which are general community associated infections e.g. Measles, Mumps, Influenza, Meningitis. The development of the computerised infectious disease reporting system (CIDR) and the inclusion of microbiology laboratories as legal notifiers (since 2004) has meant that national surveillance information is more reliable than ever before. The HPSC has also become the leading authority through which national guidance on matters in relation to infectious disease are issued.

Another key development has been the publication and implementation of the Strategy for the Control of Anti-microbial Resistance in Ireland (SARI Report, 2001). Funding to underpin this strategy has been provided to all health boards since 2001 and each health board was duly required to establish a committee consisting of key personnel from both the hospital and community setting with an interest in prevention of anti-microbial resistance. With the support of these committees a number of key surveillance staff have been appointed throughout the country including, public health and laboratory based Surveillance Scientists, Anti-microbial Pharmacists and Infection Control Nurses. Although there are still deficits within the system with regard to personnel and resources, this strategy aims to provide a framework for the surveillance of anti-microbial resistance, the monitoring of antibiotic consumption, provide guidance on appropriate use of antibiotics and infection control measures and support education and research in the area of anti-microbial resistance. In 2005, two important reports on hospital surveillance and infection control measures were published by the HPSC in conjunction with the National SARI committee: "Control and Prevention of MRSA in Hospitals and in the Community" and "Guidelines for Hand Hygiene in Irish Healthcare Settings". However, there is a long way to go to implement fully the recommendations of the Strategy. For example, Ireland is one of the few countries without a specific surveillance system for healthcare associated infection.

In summary, while there are strong links between the HPSC and Public Health professionals nationally, progress in fostering links with hospitals and the developing national surveillance initiatives within the hospital setting have been limited.

2.8 Main Surveillance issues in the Hospital Setting

This section aims to describe some of the main surveillance issues that have a particular impact in the hospital setting in terms of service delivery, economic cost and patient welfare.

Multi drug resistance

Microbes are the oldest forms of life on earth. It is estimated that they constituted the beginnings of life on this planet approximately four billion years ago. Over this time frame they have had a profound impact on the bioshpere and micro-organisms have diversified to populate every habitat on the planet. Long before man arrived on the

scene, bacteria in particular had already evolved ingenious techniques to ensure their continued survival. These biological techniques have developed primarily due to the necessity to compete for nutrients and space. One of the most successful of these biological responses is the production of chemicals or metabolic by-products that are toxic to other bacterial and fungal species. Of course, the producing micro-organism must itself be resistant to its own product and must be able to pass this resistance to its progeny if it is to survive. In the last 70 years, these bactericidal and bacteriostatic chemicals, commonly now known as antibiotics, have been exploited by man to treat infections in both humans and animals. Prior to the introduction of antibiotics, man was extremely vulnerable to any bacterial or fungal infection. Indeed, in the 17th Century, 25% of the population of Europe died from Bubonic Plague, caused by the highly virulent bacterium *Yersinia pestis*. Today, a wide variety of antibiotics are available for treatment of infection. However, the natural existence of bacterial and fungal resistance to these antibiotics and the ability of these resistance genes to be transmitted between micro-organisms, proves to be a serious clinical issue. In fact, the overuse of antibiotics has provided an environment in the hospital setting which can select for resistant micro-organisms.

Contracting an antimicrobial resistant micro-organism in a healthcare setting has been shown to increase a patients morbidity and risk of mortality (Wenzel, 2007). Furthermore, an aggressive treatment regime, in conjunction with longer hospital stays, is often required to cure the infection, substantially increasing patient suffering and healthcare costs. In a hospital setting, where there may be many bacteria with resistance to antibiotics, the emergence of strains which are resistant to multiple drugs poses a serious threat and unfortunately, some of these resistant strains are now surfacing in the community setting as well. Targeted surveillance of antimicrobial resistance (AMR) patterns which requires that the data is of good quality, that the methodology for capture and analysis is in accordance with recognised standards (e.g. the Surveillance standards as outlined by WHO (WHO, 2001)) and that the dissemination of timely information influences decision making, has the potential to reduce the burden of AMR on the hospital system.

Noscomial infections

There are some variation on the definition of a nosocomial or hospital acquired infection but the US CDC definition is widely accepted: “a localised or systemic

condition that 1) results from an adverse reaction to the presence of an infectious agent(s) or its toxin(s) and 2) that was not present or incubating at the time of admission to the hospital" (Garner *et al.*, 1996). In practice this usually means that an infection arising 48 hours after hospital admission constitutes a nosocomial infection. As well as patient suffering, the economic cost, in terms of increased length of stay and additional drug therapy for nosocomial infections are substantial. Many factors influence the development of these infections including the microbial agent itself and its resistance profile, the patients susceptibility to infection and extrinsic environmental factors (WHO, 2002). A more extended discussion on nosocomial infection is provided in Chapter 3.

Methicillin Resistant S. aureus

The bacterium, *Staphylococcus aureus*, is a Gram positive, non-motile, cluster forming coccus. It is generally part of the normal flora of nasal passages, skin and mucous membranes of the upper respiratory tract and colonisation of healthy individuals in this manner, is generally non-pathogenic. However, under certain circumstances, *S. aureus* may invade open wounds and/or burns and has been known to cause osteomyletis, endocarditis and septicaemia. The immunocompromised and the elderly are also at high risk from infection with *S. aureus*.

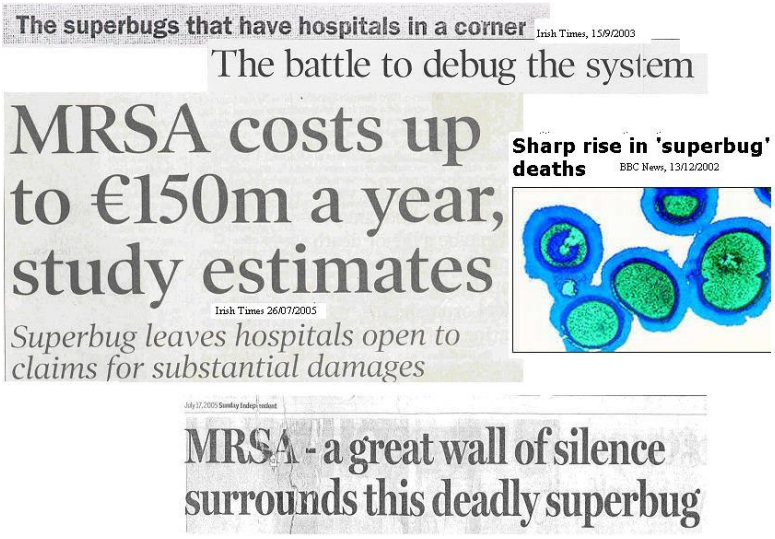
Benzylpenicillin, a β-lactam antibiotic, was first used in the 1950s to treat *S. aureus* infection. However, *S. aureus* rapidly evolved resistance to benzylpenicillin by producing a β-lactamase – an enzyme that hydrolysed the antibiotic, rendering it ineffective. By 1959, a synthetic penicillin derivative called Methicillin had been manufactured which could inactivate the β-lactamase enzyme. Almost as soon as it was introduced in the hospital setting, *S. aureus* acquired resistance to Methicillin as well. This new bacterial strain was termed Methicillin Resistant *Staphylococcus aureus* or MRSA. Methicillin resistance was achieved by the acquisition of a Penicillin Binding Protein from another bacterial species. In recent years, resistance to other antibiotics (through genetic transfer of resistance conferring genes) has also rapidly developed and MRSA has become almost endemic in some hospital settings. Current treatment options for MRSA infection are limited, with the glycopeptide antibiotics, Vancomycin and Teicoplanin considered a last line of defense.

"The emergence of vancomycin resistant S. aureus would represent the most important issue in antibiotic resistance since the dawn of the antibiotic era. A common, virulent, and transmissible bacterial agent with no known effective therapy would set infectious diseases back 60 years"

Edmond et al., (1996)

In recent years there has been substantial recognition of the problem of MRSA in the hospital setting by both the medical profession and the public alike. Some typical media headlines are shown in Figure 2.1.

Figure 2.1 **Typical media headlines in relation to MRSA**



There is much difficulty in treating infected MRSA patients and MRSA is associated "with worse outcomes and higher costs" than infected Methicillin sensitive *S. aureus* patients (Shorr, 2007). The transmissibility of the organism between patients within the hospital setting means that isolation facilities or cohorting of patients are required. In terms of surveillance, monitoring of MRSA within the hospital setting can be problematic. There is a necessity to distinguish between patients that are infected versus colonised and those that acquired the infection in hospital versus the community setting. Identifying risk factors for infection is also a major priority for MRSA surveillance. In other words there is a requirement to be able

to identify the problem in order to be able to effectively tackle it. Control of MRSA in the hospital setting will only be obtained with calculated surveillance activities in conjunction with effective infection control measures.

2.9 Collection of Hospital Surveillance Data

In general, the type of surveillance data that is important in the hospital setting can be quite different to public health surveillance data collection and includes the incidence of infections (particularly hospital acquired infections) as well as the resistance profiles of organisms isolated in the laboratory. Resistance profiles generated by the laboratory include the results of all antimicrobial sensitivity tests performed and may comprise up to 20 individual data items. Furthermore, in order to identify risk factors for certain infections, clinical information often needs to be gathered. While it can be useful to have all of these data available at a service level, more important trends and patterns in data can be identified when the data is stratified, for example by hospital speciality (e.g. surgical patient rates, ICU rates, renal dialysis patients). Furthermore, the provision of resistance profiles for hospital clinicians for specific infections is of critical importance for determining the optimum treatment strategies for patients. This aggregate information is also particularly important for the Consultant Microbiologist in determining a local antibiotic policy for the hospital allowing clinicians to provide more appropriate empiric treatment regimes for patients. Therefore local surveillance of resistance profiles is a key element in any hospital surveillance program.

2.10 Why is local hospital based surveillance and analysis important?

There are a number of reasons why local hospital based surveillance and analysis is essential. At a basic level, this type of methodology can aid in the identification of sources or points of origin of infection in the hospital setting, can provide a history of the epidemiology of particular infections in the hospital and can generate baseline data for future comparisons. Furthermore, identification of risk factors for particular infections in a particular setting can target specific patient cohorts for extra precautions or interventions which may stem the transmission of disease. In a similar way, explicit monitoring of the status (e.g colonised or infected with MRSA) of high risk patients can alert healthcare workers of the requirement for patient isolation and barrier nursing methods.

Local hospital based surveillance can also make a contribution to the practice of evidence based medicine within the hospital. For example, good local surveillance can impact on the design and development of the hospital infection control policies and on both hospital and community antibiotic prescribing guidelines. Indeed, hospital laboratories routinely provide a diagnostic service for GPs working in the community and in nursing homes. It is also an important function of any hospital surveillance system to provide data and analyses for these service users as resistance rates and disease incidence are often quite different when comparing hospital and community data. Also, as no hospital operates in a stand-alone fashion it is important that each hospital makes a contribution towards both national and international surveillance initiatives for the good of the wider community. Interestingly, a needs evaluation carried out by Wilson *et al.* (2002) with users of the Nosocomial Infection National Surveillance Scheme (NINSS) in England identified "local data collection and analysis systems" as one of the areas that users highlighted for improvement. Clearly there is a wide interest in the development of local hospital based surveillance systems.

2.11 Conclusion

This chapter has described background information in relation in infectious disease surveillance with particular emphasis on the requirements for the hospital setting. In addition, much of the terminology used throughout this thesis was introduced.

Chapter 3

3.1 Introduction

This chapter will present the state of the art in international healthcare associated or nosocomial infection surveillance. Particular emphasis will be placed on types of surveillance, e.g. Surgical Site Infection, that are considered appropriate indicators of the state of infection control practice within the hospital setting. Minimum datasets for surveillance of these nosocomial infections will also be examined.

3.2 Methodology

The literature review performed for this chapter consisted of obtaining peer reviewed journal articles and reports by accessing various search engines including PubMed, Scirus and Google. Among the keywords used in these searches were “surveillance”, “hospital surveillance” “hospital acquired infection”, “nosocomial infection”, “bacteraemia surveillance” “surgical site infection” and “national surveillance program”. The websites for specific agencies with a remit for national nosocomial surveillance were also searched including the HPA (UK) website, the ECDC (European) website, the WHO (International) website and the CDC (US) website. Where available, national guidelines were also reviewed.

3.3 International Nosocomial Infection Surveillance

Local hospital based surveillance systems designed to gather epidemiological information on nosocomial pathogens for infection prevention and control measures are an important aspect of service provision. Despite this, gathering detailed information on the design, implementation and standards for local hospital based surveillance systems is a difficult task. While a number of journals publish results gathered through these programs, descriptions of the surveillance systems themselves are brief. This stems from the complex nature of infectious disease epidemiology and the resources that are required at a local level to invest in stand alone surveillance systems. To compensate for this, several countries have implemented national programs for the surveillance of nosocomial infections which provides a framework for local hospital participation in a standardised and validated surveillance system. Indeed active surveillance of healthcare associated infection in this manner with concomitant feedback to clinicians has proven, beyond doubt, to reduce hospital infection rates (Brandt *et al*., 2006; Barwolff *et al*., 2006; Gastmeier *et al*., 2006;

Gastmeier *et al*., 2005; Zuschneid *et al*., 2003; Geubbels *et al*., 2006; Schneeberger *et al*., 2002; McConkey *et al*. 1999).

The longest running national noscomial infection surveillance program is the American NNIS system (National Nosocomial Infection Surveillance, currently part of the NHNS web based system for data collection), first developed in 1970 and currently managed and sponsored by the CDC in Atlanta (Emori *et al*., 1991; CDC NNIS Website, 2007). This system is often used as the benchmark or gold standard for the design and implementation of national nosocomial surveillance systems as it contains well established, comprehensive, standardised sets of definitions, methods and guidelines. Hospital participation in the scheme is voluntary and each hospital may choose to contribute data to one or many separate surveillance modules including a device associated infection module, a medication associated module and a procedure associated module (see Table 3.1 for more detail). These modules target mainly high risk patients most at risk of developing a hospital acquired infection if infection control practices are lacking. Patient demographic details, specific details on the infection and related risk factors and details on the outcome are gathered by the hospital either on paper forms or through a custom designed web-based system. The CDC uses the data submitted to monitor, analyse, interpret and produce risk adjusted data and reports on the incidence and risk factors associated with nosocomial infection.

Table 3.1 NHSN Modules

Module	Events data collected on:
Device-Associated Module	Central Line-Associated Bloodstream Infection (CLABSI) Event
	Ventilator-Associated Pneumonia (VAP) Event
	Catheter-Associated Urinary Tract Infection (CAUTI) Event
	Dialysis Incident (DI) Event
Medication-Associated Module	Antimicrobial Use and Resistance (AUR) Option
Procedure-Associated Module	Surgical Site Infection (SSI) Event
	Post-procedure Pneumonia (PPP) Event

An Australian surveillance system for nosocomial infection (VICNISS) was established in 2002 based on modules originally designed in 1986 by the CDC NNIS surveillance system. These modules can be seen in Table 3.2. The VICNISS currently covers 98% of all public hospitals in Victoria. This system gathers information from individual hospitals and feeds back aggregate data analysis on “risk adjusted,

procedure specific infection rates". This type of analysis allows the generation of a national performance indicator against which individual hospitals can compare themselves and identify if there is a requirement to modify their infection control measures and interventions. Furthermore, risk adjusted data can be compared with information from other national surveillance systems.

Table 3.2 VICNISS Modules

Module	Events
Type 1 Surveillance Modules (hospitals >100 beds)	Surgical Site (SSI) Surveillance Component
	Intensive Care Unit Surveillance (ICU) Component
	Neonatal Intensive Care Unit (NNL) Component
Type 2 Surveillance Modules (hospitals <100 beds)	Surgical Antibiotic Prophylaxis
	Health Care Workers and Measles Vaccination
	Health Care Workers and Hepatitis B Vaccination
	Peripheral Venous Catheter (PVC) Use
	Multi-resistant Organism (MRO)
	Primary Laboratory Confirmed Bloodstream Infection (LC-BSI)
	Outpatient Haemodialysis Centre
	Occupational Exposure
	Surgical Site Infection
	Surgical Infection Report

In Europe in the early 1990s, some countries were attempting to establish national nosocomial surveillance systems based on the CDC NNIS model. In order to aid this process and try to streamline the definitions and methods for the surveillance of SSI and ICU pathogens in particular, the European Parliament and Council supported two major surveillance projects in relation to Healthcare associated infection (Pittet, 2005), namely HELICS (Hospital in Europe Link for Infection Control through Surveillance) and EARSS (European Antimicrobial Resistance Surveillance System). A group of internationally acknowledged nosocomial infection experts, existing surveillance nosocomial networks and members of WHO met to foster co-operation between member states in relation to surveillance of Healthcare Associated Infection (HAI) and to develop a strategy for surveillance and control. Standardised protocols, definitions and risk adjusted methods for gathering of information on ICU and SSI infections and overall prevalence of nosocomial infections, through the HELICS network, were agreed among states. This was

achieved through a specifically designed software system which was provided to each participating hospital and allows input, analysis and export of hospital specific data to the HELICS network. The majority of EU member states submit some form of data to HELICS however, the Republic of Ireland does not currently participate in HELICS. An example of some of the European networks which feed into HELICS are shown in Table 3.3.

Table 3.3 Participants in the HELICES project and surveillance undertaken

Country	System/Body Responsible	Type of Surveillance
England	Health Protection Agency (HPA)	SSI
Northern Ireland	Healthcare Associated Infection Surveillance Centre (HISC)	SSI
Wales	Welsh Healthcare Associated Infection Programme (WHAIP)	SSI
Scotland	Scottish Surveillance of Healthcare Associated Infection (SSHAIP)	SSI
Belgium	National Surveillance of Infections in Hospital (NSIH)	SSI & ICU
Luxembourg	ICU Network	ICU
Portugal	ICU Network	ICU
Spain	ICU Network	ICU
France	Reseau Alerte Investigation Surveillance des Infections (RAISIN)	SSI & ICU
Austria	Austrian Nosocomial Infection Surveillance System (ANISS)	SSI & ICU
Hungary	SI Network	SSI
Greece	SSI Network	SSI
Lithuania	SSI Network	SSI
Poland	SSI Network	SSI
Finland	Kansanterveyslaitos Folkhalsoininstutet (KTL)	SSI
Norway	SSI and ICU Network	SSI & ICU
Germany	Krankenhaus Infektions System (KISS)	SSI & ICU
Netherlands	Prevention of Noscomial Infections by Surveillance (PREZIES)	SSI

The European Antimicrobial Resistance Surveillance System (EARSS) funded by DG SANCO of the European Commission is an international network aiming to collect comparable and reliable antimicrobial resistance (AMR) data for public health action. The principal element of EARSS is the network of participating laboratories that perform antimicrobial susceptibility testing routinely on clinical specimens of invasive (blood or CSF) "indicator organisms" including *S. aureus*, *S. pneumoniae*, *E. coli*, *K. pneumoniae*, *P. aeruginosa*, *E. faecium* and *E. faecalis*. Data is reported either through a software program (WHONET) or on specifically designed forms to a national co-ordinator who then submits the data to EARSS. Feedback to each hospital is provided by the national co-ordinators on a quarterly basis. This program provides a

comparison between countries on the incidence and prevalence of various antibiotic resistant organisms in Europe.

3.4 Nosocomial Surveillance in the Irish Setting

Until recently Irish hospitals were not obliged to provide any national body with figures on incidence of infections detected in their setting. This changed in 2004 with the introduction of new legislation (SI 707, 2003) to make hospital microbiology laboratories legal notifiers of particular infectious diseases (the list of notifiable diseases can be seen in Appendix 1). However, there are many nosocomial infections that are not on this statutorily notifiable list, for example *Clostridium difficile* and non-invasive MRSA. Therefore, over the years, information on nosocomial infection in the Irish setting has been limited to a small number of nationally organised studies (Table 3.4) and research conducted by individual hospitals/research groups on specific pathogens or sites (Table 3.5).

Table 3.4 Examples of National Nosocomial Studies/Projects

Study	Infections under study	Reference
The Alexander Project 1992	Various Nosocomial Infections	Felmingham & Gruneberg, 2000
The North/South Study of MRSA in Ireland 1999	*S. aureus* MRSA	Available from : http://www.dohc.ie/publications/study_of_mrsa_in_ireland_1999.htm
The Prevalence Survey of Healthcare Associated Infection 2006	Various Nosocomial Infections	Available from: http://www.ndsc.ie/hpsc/
EARSS Project (1999 - ongoing)	*S. aureus* MRSA Enterococcus faecium Enterococcus faecialis, Streptococcus pneumoniae	Available from: http://www.rivm.nl/earss/

Table 3.5 Examples of Publications on specific nosocomial infections in Ireland*

Organism/Site under Surveillance	Reference
S. aureus including MRSA	Rossney *et al*., 2007, 2005; Roche *et al*., 2006; Whyte *et al*., 2005; Cotter *et al*., 1997; Carroll *et al*., 1989
Serratia marcescens	Hejazi *et al*., 1998; 2000
Drug resistant Entercoccus (VRE)	Nourse *et al*., 2000; Lavery *et al*., 1997
Clostridium difficile	Kyne *et al*., 1998
Surgical Site Infections	Creamer *et al*., 2002
Candida	Boo *et al*., 2005
Pseudomonas	Falkiner & Keane, 1979
E. coli	Chulain *et al*., 2005

*Note: this list is not meant to be exhaustive

Results from the most recent national survey on nosocomial infection (The Prevalence Survey of Healthcare Associated Infection (PSHAI), 2006), in which 45 Irish hospitals participated, demonstrated that 4.9% of patients had a healthcare associated infection at the time of the survey. This equates to 1 in 20 admissions or approximately 25,000 patients a year contracting a nosocomial infection in Irish hospitals. Furthermore, 4.3% of patients with recent surgery had a surgical site infection and 38% of bloodstream infections reported were associated with the presence of a central venous catheter. There are also a number of worrying trends in Irish EARSS data collected on invasive infections (Table 3.6; 3.7 & 3.8). For example, between 1999 and 2005, the percentage of *S. aureus* that are Methicillin resistant (MRSA) has increased from 39% to 42%. Although this does not seem like a large increase over the 6 year period, Ireland has one of the highest MRSA rates in Europe and this fact is further exemplified if compared with MRSA rates in Northern European counties like Norway (0.5% in 2005), the Netherlands (0.9% in 2005), Sweden (1% in 2005) and Denmark (1.7% in 2005).

Table 3.6 Resistance of Irish *S. aureus* isolates to Methicillin.

Data taken from the EARSS website (http://www.rivm.nl/earss/)

		Total no of Isolates				
Year	***S. aureus***	**S**	**I**	**R**	**N**	**%R**
1999	Methicillin	311	0	200	511	39.1
2000	Methicillin	384	0	248	632	39.2
2001	Methicillin	465	0	333	798	41.7
2002	Methicillin	574	0	424	998	42.5
2003	Methicillin	640	0	468	1108	42.2
2004	Methicillin	753	0	533	1286	41.4
2005	Methicillin	792	0	568	1360	41.8

According to the EARSS data, resistance of other invasive organisms to particular antibiotics is also on the increase in Ireland. Resistance of invasive *E. faecium* to glycopeptide antibiotics has increase dramatically between 2002 and 2005 from 11.1% to 30.9% (Table 3.7) and over the same time period resistance of invasive *E. coli* to Fluoroquinolone antibiotics has increased almost three fold from 5.1% to 16.9% (Table 3.8). Dramatic increases in resistance of this nature make invasive infections more difficult to treat and suggest that there is an inherent inability to

control the transmission of drug resistant organisms in the Irish hospital setting. This inability is probably due to a number of factors but almost certainly include lack of standardised surveillance methods, inappropriate antibiotic prescribing and inadequate implementation of infection control measures.

Table 3.7 Resistance of Irish *E. faecium* isolates to Glycopeptides.

Data taken from the EARSS website (http://www.rivm.nl/earss/)

		Total no of Isolates				
Year	***E. faecium***	**S**	**I**	**R**	**N**	**%R**
2002	Glycopeptides	72	0	9	81	11.1
2003	Glycopeptides	107	0	25	132	18.9
2004	Glycopeptides	140	1	40	181	22.1
2005	Glycopeptides	151	1	68	220	30.9

Table 3.8 Resistance of Irish *E. coli* isolates to Fluoroquinolones.

Data taken from the EARSS website (http://www.rivm.nl/earss/)

		Total no of Isolates				
Year	***E. coli***	**S**	**I**	**R**	**N**	**%R**
2002	Fluoroquinolones	684	0	37	721	5.1
2003	Fluoroquinolones	861	0	91	952	9.6
2004	Fluoroquinolones	1062	4	147	1213	12.1
2005	Fluoroquinolones	1171	2	238	1411	16.9

3.5 Nosocomial Surveillance Indicator Datasets

With the recent increasing incidence of HAI in the Irish hospital setting, along with recent hygiene audits and programs to increase awareness regarding hand hygiene, there is the expectation that in the near future all Irish hospitals will be required to provide reliable and standardised data on nosocomial infections. Examining datasets from internationally recognised nosocomial surveillance systems and providing recommendations for the establishment of a protocol or framework for local hospital surveillance that can provide relevant surveillance data for analysis will make the transition by hospitals to "data provider" easier in the Irish setting. Furthermore, implementation of good surveillance methods within the local hospital setting will allow the impact of any infection control interventions to be specifically measured. With this in mind the following sections describe in detail the minimum datasets required for indicator surveillance of infection control according to

international systems like, NNIS, VICNISS, HELICS and EARSS and also datasets collected by some national surveillance projects e.g. PSHAI 2006.

3.5.1 Surgical Site Infection (SSI) Indicator

Surgical sites have been identified as one of the most commonly occurring sources of healthcare associated infections (Emori & Gaynes, 1993). These nosocomial infections directly increase morbidity and mortality, length of patient stay, antibiotic usage and cost of patient care (Coello *et al*., 2005). Sources of bacterial contamination during surgery include endogenous bacteria from the patient's skin, mucous membranes or viscera and exogenous bacteria from healthcare professionals, the operating environment and the instruments used during surgery. Although it is impossible to eliminate all surgical site infections (SSIs), it is important to gather information on specific hospital baseline levels, patient and healthcare associated risk factors and make co-ordinated and efficient attempts to reduce the occurrence of opportunistic infection.

One of the hallmarks of SSI surveillance is the standardised and widely accepted method of analysis based on risk stratification. Each procedure is defined based on wound class classification (e.g. clean, contaminated etc.), the length of the operation and the patient's underlying severity of illness (ASA score). Clearly, patients with a class 1 or clean wound, a short operating time and a low underlying severity of illness (low ASA score) should have a lower risk of HAI infection. This risk index allows prognostic outcomes for various patients to be assessed and also allows SSI rate comparisons between surgeons and hospitals to be made based on risk stratification. Furthermore, local changes in these risk stratified SSI rates over time can alert the infection control team to inadequacies in infection control practice. Finally as there are often not the resources to allow surveillance of all surgical procedures, these methods can allow targeted surveillance on particularly high risk patient groups or particularly high risk procedures within the hospital under study.

The data collection forms for SSIs surveillance in the NNIS/NHSN system, the VICNNIS system and the HELICS systems are shown in Appendix 2. The information gathered can generally be broken down into three main areas: General Patient/Hospital Details, Event Details and Infection Details. A comparison of the data items collected on each form is shown in Table 3.9. Of the 40 data items listed, only 15 (37.5%) appear on all three forms. These 15 essential data items include

Hospital Code, Patient Gender, Patient Age/DOB, Date Admitted, Date Discharged, Procedure Date, Procedure Code, ICD 9/10 Procedure Code, Duration of Procedure, Patient ASA Score, Wound Class, Endoscopic Approach, Infection Type, Organism Isolated and Antimicrobial Resistance Profile. Regardless of which form is used however, not all of these individual data items would originate from a single hospital source (and this is even true for the 15 essential data items that are in common on all three forms). This will be further expanded upon in Chapter 5.

Table 3.9 Comparison of Main Data Items collected by the US (NNIS/NHSN), Australian (VICNNIS) and European (HELICS) Surgical Site Infection Surveillance Systems

Category^	Data Item	Format	NHSN	VICNNIS	HELICS
P/H Detail	Hospital Code	Numeric	√	√	√
P/H Detail	Patient ID	Alpha Numeric	√	√	
P/H Detail	Patient Name	Alpha	√		
P/H Detail	MRN	Numeric		√	
P/H Detail	Sex	Male/Female	√	√	√
P/H Detail	DOB/Age	Date	√	√	√
P/H Detail	Date Admitted to Hospital	Date	√	√	√
P/H Detail	Date Discharged from Hospital	Date	√	√	√
E Detail	Procedure Date	Date	√	√	√
E Detail	Event Date	Date	√		
E Detail	Date Last Follow up Post Discharge	Date			√
E Detail	Surgeon Code	Alpha Numeric	√	√	
E Detail	Procedure Code	Alpha Numeric	√	√	√
E Detail	ICD 9/10 Procedure Code	Alpha Numeric	√	√	√
E Detail	Location	Free Text	√		
E Detail	Duration of Procedure	hrs mins	√*	√	√
E Detail	ASA Score	1-5 # or unavailable	√*	√	√
E Detail	Wound Class	1-4 $	√*	√	√
E Detail	Implant	Yes No	√	√	
E Detail	Multiple Procedures	Yes No	√	√	
E Detail	General Anesthesia	Yes No	√		
E Detail	Endoscopic Approach	Yes No	√	√	√
E Detail	Trauma	Yes No	√	√	
E Detail	Emergency/Elective	Yes No		√	√
E Detail	Prophylatic Antibiotic given	Yes No		√	√
E Detail	Antibiotic Name	Free Text		√	
E Detail	Time Given	Prior to incision, after incision, etc		√	
E Detail	Antibiotic Continued for >24hrs	Yes No		√	
I Detail	Infection Detected	Yes No		√	√
I Detail	Infection Date	date		√	√
I Detail	When Detected	Admission/Post Discharge/Readmission	√	√	
I Detail	Infection Type	Superficial or Deep Incision/Organ Space	√	√	√
I Detail	Laboratory Test	Culture/Visualisation/Other		√	
I Detail	Specimen Type	Blood/CSF/Other		√	
I Detail	Organism Isolated	Free Text	√	√	√
I Detail	Resistance Profile	Sensitive, Resistant, Intermediate	√	√	√
E Detail	Other Comments	Free Text	√	√	
I Detail	Secondary BSI	Yes No	√		
E Detail	Died	Yes No	√		√
E Detail	SSI Contributed to death	Yes No	√		

Notes: ^P/H = general patient/hospital detail; E = Event Detail; I = Infection Detail
* although these data items are not shown on the data collection form available in Appendix ?, they are collected through the current web based NHSN system
# ASA Score: 1 = Normally Healthy Patient; 2 = Patient with Mild Systemic Disease; 3 = Patient with Sever Systemic Disease that is not incapacitating; 4 = Patient with Incapacitating Systemic Disease that is a constant threat to life; 5 = Moribund patient who is not expected to survive for 24 hrs with or without operation.
$ 1 = Clean Wound; 2 = Clean-Contaminated Wounds; 3 = Contaminated Wounds; 4 = Dirty or Infected Wounds

3.5.2 ICU Infection Indicator

The intensive care unit (ICU) in any hospital is considered one of the most high risk areas for the acquisition of nosocomial infections. This is due to a number of reasons including the population of severely ill patients, the requirement to use invasive devices and equipment (e.g. Ventilators, indwelling catheters etc.) and the high level of nursing and medical attention that is essential for the ICU patient. Indeed, contracting a nosocomial infection as an ICU patient is associated with poor patient outcomes or in other words a high level of mortality (Suljagic *et al*., 2005; Rello *et al*., 2002). Therefore, surveillance of infection in the ICU in tandem with good infection control practices is paramount in order to control the spread of opportunistic infection, identify targets for improvement and save lives.

The data collection forms for ICUs surveillance in the NNIS/NHSN system, the VICNNIS system and the HELICS systems are shown in Appendix 2. The information gathered can generally be broken down into three main areas: General Patient/Hospital Details, Event Details and Infection Details. A comparison of the data items collected on each form is shown in Table 3.10. Of the 47 data items, 13 (28%) are similar on the three forms. These data items include Patient ID, Gender, DOB/Age, Date Admitted to Hospital, ICU Type/Code, Died, Risk Factor – Central Line, Risk Factor – TPN, Risk Factor – Ventilator, Major Infection Site, Secondary Bloodstream Infection, Organism Name and Antimicrobial Resistance Profile. Again not all of these essential data items stem from any one IT system in the hospital. In particular, identifying relevant risk factors associated with the infection can only be obtained from ICU staff involved in ongoing patient care. Comparison of the surveillance forms also highlights another important issue in relation to risk factors and that is that there is not a lot of agreement between the forms on which information should be collected. In all 13 risk factor data items were mentioned between the three forms. Clearly, each hospital (based on its ICU and patient types) must make a decision as to which information to collect that will provide them with the most beneficial data for subsequent infection control action in their particular environment.

Table 3:10 Comparison of Main Data Items collected by the US (NNIS/NHSN), Australian (VICNNIS) and European (HELICS) ICU Infection Surveillance Systems

Category^	Data Item	Format	NHSN	VICNNIS	HELICS
P/H Detail	Hospital Code	Numeric		√	√
P/H Detail	Patient ID	Alpha Numeric	√	√	√
P/H Detail	Patient Name	Alpha	√		
P/H Detail	MRN	Numeric		√	
P/H Detail	Sex	Male/Female	√	√	√
P/H Detail	DOB/Age	Date	√	√	√
E Detail	Origin of Patient	hospital/Long Term Care/Community			√
P/H Detail	Date Admitted to Hospital	Date	√	√	√
E Detail	Type of Admission	Medical/Surgical			√
E Detail	Trauma	Yes/No			√
E Detail	Impaired Immunity	Yes/No			√
E Detail	Antimicrobial Treatment (at admission)	Yes/No			√
P/H Detail	Date Admitted to ICU	Date		√	√
P/H Detail	Date Discharged from ICU	Date		√	√
P/H Detail	ICU Type/Code	List	√	√	√
P/H Detail	Birthweight in grams (Neonates)	Numeric	√		
E Detail	Vaginal Delivery	Yes/No	√		
E Detail	Died	Yes/No	√	√	√
E Detail	Date of Death	Date		√	
E Detail	Comments	Free text		√	
E Detail	Operation	Yes/No	√		
E Detail	Risk Factor - Central Line	Yes/No & Dates	√	√	√
E Detail	Risk Factor – TPN	Yes/No & Dates	√	√	√
E Detail	Risk Factor – Intubation	Dates			√
E Detail	Risk Factor - Naso/Oro intestinal tube	Dates			√
E Detail	Risk Factor – Ventilator	Yes/No & Dates	√	√	√
E Detail	Risk Factor - Urinary Catheter	Yes/No & Dates	√		√
E Detail	Risk Factor - Bladder instrumentation	Yes/No	√		
E Detail	Risk Factor – SSI	Yes/No	√		√
E Detail	Risk Factor - Peripheral Line	Yes/No	√		
E Detail	Risk Factor - Umbilical Catheter	Yes/No	√		
E Detail	Risk Factor - Invasive Device/Procedure	Yes/No	√		√
E Detail	Risk Factor - Acute Coronary Care	Yes/No			√
E Detail	Risk Factor - Glasgow Coma Scale	Numeric			√
E Detail	Antimicrobials Used in ICU	Name/Date/Prophylaxis/Empiric			√
I Detail	Infection ID	Numeric	√		
I Detail	Major Infection Site	Pneumonia/BSI	√	√	√
I Detail	Specific Infection Site	Free text	√	√	
I Detail	Infection Date	Date		√	√
I Detail	Secondary BSI	Yes/No	√	√	√
E Detail	Origin of BSI	Free text			√
E Detail	Maternally acquired	Yes/No	√		
E Detail	Relationship to Death	Directly Related etc	√		
I Detail	Laboratory Diagnosis	Culture/Ag-Ab test/Visulation/Other	√	√	
I Detail	Specimen Type	Free text	√	√	
I Detail	Organism Name	Free text	√	√	√
I Detail	AMR Profile	Sensitive/Resistant/Intermediate	√	√	√

3.5.3 Bloodstream Infection (BSI) Indicator

Septicaemia or blood poisoning is a bacterial infection of the bloodstream which can be common in the older population due to underlying chronic disease which causes susceptibility to infection (Wenzel & Edmond, 2001). The infection itself may develop from hospital or community acquired infection and symptoms include fever, chills, low blood pressure, rash and can result in multiple organ failure if not treated urgently. The morbidity and mortality rates for septicaemic patients is high. In an era when antibiotic resistant organisms are common, septicaemia remains a potentially increasing problem and surveillance of all bloodstream infections is becoming a necessity in order to identify common causative organisms and risk factors within the local hospital environment. Finally, BSI surveillance is used as a measure to identify the evolution and presence of highly drug resistant organisms within the hospital setting which by their nature are difficult to treat.

The data collection forms for Bloodstream Infection surveillance in the NNIS/NHSN system, the VICNNIS system and the EARSS systems are shown in Appendix 2. The information gathered can generally be broken down into three main areas: General Patient/Hospital Details, Event Details and Infection Details. A comparison of the data items collected on each form is shown in Table 3.11. Of the 36 data items, only 7 (19%) are similar between the forms. These include Hospital code, Patient ID, Gender, DOB, Admission Date, Organism Name and Antimicrobial Resistance Profile. Although the similarity between the forms is low, there is a second clinical details form that can also be filled out in the EARSS system which collects more detailed information on BSI risk factors. This form is also included in Appendix. 2.

Table 3.11 Comparison of Main Data Items collected by the US (NNIS/NHSN), Australian (VICNNIS) and European (EARSS) Bloodstream Infection Surveillance Systems

Category^	Data Item	Format	NNIS	VICNNIS	EARSS
P/H Detail	Hospital Code	Numeric	√	√	√
P/H Detail	Hospital Department	List	√		√
P/H Detail	Laboratory Code	Alpha Numeric			√
P/H Detail	Current Date	Date			√
P/H Detail	Patient ID	Numeric	√	√	√
P/H Detail	Patient Name	Alpha	√		
P/H Detail	MRN	Numeric		√	
P/H Detail	Sex	Male/Female	√	√	√
P/H Detail	DOB	Date	√	√	√
P/H Detail	Admission Date	Date	√	√	√
P/H Detail	Discharge Date	Date	√		
E Detail	Origin of Patient	Admitted/Outpatient/Unknown			√
E Detail	Died	Yes/No	√		
E Detail	Comments	Free Text		√	
E Detail	BSI Contributed to Death	Yes/No	√		
E Detail	Clinical Diagnosis	Free Text			√
E Detail	Date of Event	Date	√		
E Detail	Specific Event	Lab Confirmed/Clinical Sepsis	√		
E Detail	Post Procedure BSI	Yes/No	√		
E Detail	Date of Procedure	Date	√		
E Detail	Procedure Code	Numeric	√		
E Detail	ICD 9/10 Procedure Code	Numeric	√		
E Detail	Risk Factors – SC* - Temporary Central Line	Yes/No	√		
E Detail	Risk Factors - NICU - Umbilical Catheter	Yes/No	√		
E Detail	Risk Factors - NICU - Birth weight (g)	Numeric	√		
E Detail	Central Line insitu	Yes/No	√	√	
E Detail	Peripheral Line insitu	Yes/No		√	
E Detail	Detected >48hrs after admission	Yes/No		√	
I Detail	Organism Name	Free Text/List	√	√	√
I Detail	When Detected	During Admission/Post Discharge/Readmiss		√	
I Detail	Specimen Collection Date	Date		√	√
I Detail	Isolate Sample No	Numeric			√
I Detail	Major Infection Site	Free Text/List		√	√
I Detail	AMR Profile	Sensitive, Resistant, Intermediate	√	√	√
I Detail	MIC Results	Numeric			√

Notes: *SC = Speciality Care Area

3.5.4 Nosocomial Prevalence Surveys

A Nosocomial Prevalence survey is used in order to ascertain how often a nosocomial infection occurs in a population during a particular time period. Often these studies are carried out at a national level, the purpose of which is to provide information on trends in prevalence of infection, and exposure of the population to risk factors and antibiotics. Data can be extrapolated to describe the annual estimated prevalence of nosocomial infection and the cost of these infections to the healthcare system. Furthermore, data can be compared over time with that of other countries to assess how well nosocomial infections are being dealt with. Finally, nosocomial prevalence surveys can be used as a validation tool for ongoing incidence surveys like HELICS. These prevalence surveys are often carried out by the local hospital Infection Control Team over one particular day. The advantage of these surveys is that they are not seen as an ongoing burden to the Infection Control team and require few additional resources if restricted to a single day. If carried out at regular intervals, local prevalence surveys within hospitals can identify problem issues and changing patterns of infection over time although they should not be a replacement of continuous surveillance.

The data collection forms for two nosocomial prevalence surveys from HELICS and Prevalence Survey of Healthcare Associated Infection 2006 are shown in Appendix 2. The information gathered can generally be broken down into three main areas: General Patient/Hospital Details (Table 3.12), Risk Factor Details (Table 3.13) and Infection Details (Table 3.14). Comparison of these data items demonstrate the wide range of information that can be collected during a one day prevalence survey and also emphasise the requirement of the local infection control team members to gather patient related risk factor data that is generally not available in electronic format within the hospital setting.

Table 3.12 Comparison of Main Survey & Patient Details Data Items collected by the Prevalence Survey of HCAI 2006 and European (HELICS) Nosocomial Prevalence Survey

Category	Data Item	Format	PSHCAI	HELICS
Survey Details	Hospital	Code	√	√
Survey Details	Country	List		√
Survey Details	Date of Survey	Date	√	√
Survey Details	Questionnaire Number	Numeric		√
Survey Details	Consultant Speciality	Code	√	
Survey Details	Ward/Unit	List		√
Survey Details	Ward Speciality	Code	√	
Survey Details	Local Ward Identifier	Code	√	
Patient Details	Sex	Male/Female	√	√
Patient Details	Patient ID	Numeric		√
Patient Details	Birthweight (Neonates)	Numeric		√
Patient Details	Age	Numeric	√	√
Patient Details	Date of Admission	Date	√	√
Patient Details	Bed Number	Numeric		√

Table 3.13 Comparison of Main Risk Factor Details Data Items collected by the Prevalence Survey of HCAI 2006 and European (HELICS) Nosocomial Prevalence Survey

Category	Data Item	Format	PSHCAI	HELICS
Risk Factor Details	Indwelling Urinary Catheter in situ	Yes/No	√	√
Risk Factor Details	Urinary catheter within last 7 days	Yes/No	√	
Risk Factor Details	Other bladder instrumentation in situ	Yes/No	√	
Risk Factor Details	Other bladder instrumentation within last 7 days	Yes/No	√	
Risk Factor Details	Peripheral intravascular catheter in situ	Yes/No	√	√
Risk Factor Details	Peripheral intravascular catheter within last 7 days	Yes/No	√	
Risk Factor Details	Central Vascular Catheter	Yes/No		√
Risk Factor Details	Mechanical ventilation	Yes/No	√	√
Risk Factor Details	Mechanical ventilation within last 7 days	Yes/No	√	
Risk Factor Details	Parenteral nutrition	Yes/No	√	√
Risk Factor Details	Parenteral nutrition within last 7 days	Yes/No	√	
Risk Factor Details	Currently receiving systemic antibiotics	Yes/No	√	
Risk Factor Details	IV antibiotics	Yes/No	√	
Risk Factor Details	Antimicrobial Used (name)	List		√
Risk Factor Details	Surgery within last 30 days with no implant	Yes/No	√	
Risk Factor Details	Date of Surgical Intervention	Date		√
Risk Factor Details	Procedure category	Yes/No	√	√
Risk Factor Details	ASA Score	Numeric		√
Risk Factor Details	Duration of Procedure	hr mins		√
Risk Factor Details	Class of Operation	Numeric		√
Risk Factor Details	Procedure Elective	Yes/No		√
Risk Factor Details	Procedure Endoscopic	Yes/No		√
Risk Factor Details	Surgery within last year involving implant	Yes/No	√	
Risk Factor Details	Procedure category	Yes/No	√	
Risk Factor Details	Other invasive procedure	Yes/No	√	
Risk Factor Details	Current confirmed /suspected norovirus	Yes/No	√	
Risk Factor Details	Current *C. difficile* diarrohea	Yes/No	√	
Risk Factor Details	Neutropenia	Yes/No		√

Table 3.14 Comparison of Main Infection Details Data Items collected by the Prevalence Survey of HCAI 2006 and European (HELICS) Nosocomial Prevalence Survey

Data Item	Format	PSHCAI	HELICS
Any healthcare associated infections	Yes/No	√	
Infection Sites	Free Text		√
Date of Onset	Date		√
Culture Result	Positive/negative/not done/other test		√
Microorganism Name	Code		√
Primary BSI	Yes/No	√	
MRSA causative BSI organism	Yes/No	√	
BSI Central Line related	Yes/No	√	
Pneumonia	Yes/No	√	
Type of Pneumoniae	Clinically or Lab defined/Immunocompromised	√	√
MRSA causative pneumoniae organism	Yes/No	√	
Secondary BSI to pneumoniae	Yes/No	√	
Ventilator related pneumoniae	Yes/No	√	
Urinary tract infection	Yes/No	√	
Type of UTI	Symptomatic/Asymptomatic/Other UT infection	√	
MRSA causative UTI organism	Yes/No	√	
Secondary BSI to UTI	Yes/No	√	
UTI Catheter related	Yes/No	√	
SSI	Yes/No	√	
Type of SSI	Superficial or Deep incisional/Organ-Space	√	
MRSA causative SSI organism	Yes/No	√	
Secondary BSI to SSI	Yes/No	√	
Procedure category for Surgery	Yes/No	√	
Bones & Joint Infection	Yes/No	√	
MRSA causative Bone & Joint organism	Yes/No	√	
Secondary BSI to Bone & Joint infection	Yes/No	√	
Central Nervous System (CNS) Infection	Yes/No	√	
MRSA causative CNS organism	Yes/No	√	
Secondary BSI to CNS infection	Yes/No	√	
Cardiovascular System Infection	Yes/No	√	
MRSA causative Cardiovascular System organism	Yes/No	√	
Secondary BSI to Cardiovascular System infection	Yes/No	√	
Eyes, ENT or mouth Infection	Yes/No	√	
MRSA causative Eyes, ENT or mouth organism	Yes/No	√	
Secondary BSI to Eyes, ENT or mouth infection	Yes/No	√	
Gastrointestinal Infection	Yes/No	√	
MRSA causative Gastrointestinal organism	Yes/No	√	
Secondary BSI to Gastrointestinal infection	Yes/No	√	
Reproductive Tract Infection	Yes/No	√	
MRSA causative Reproductive Tract organism	Yes/No	√	
Secondary BSI to Reproductive Tract infection	Yes/No	√	
Skin & Soft Tissue Infection	Yes/No	√	
MRSA causative Skin & Soft Tissue organism	Yes/No	√	
Secondary BSI to Skin & Soft Tissue infection	Yes/No	√	
Systemic Infection	Yes/No	√	
MRSA causative Systemic organism	Yes/No	√	

Secondary BSI to Systemic infection	Yes/No	√	
Lower Respiratory Tract Infection	Yes/No	√	
MRSA causative Lower Respiratory Tract organism	Yes/No	√	
Secondary BSI to Lower Respiratory Tract infection	Yes/No	√	

3.6 Conclusion

Surveillance of nosocomial infections is an important component of the hospital surveillance system. The types of surveillance described in this chapter are complex and represent the state of the art in terms of nosocomial surveillance. Clearly, careful planning is needed when implementing such systems in the hospital setting. As a result, some of the data summarised in this chapter was incorporated into an evaluation of a surveillance system structure presented in Chapter 5.

Chapter 4. Closing the loop

4.1 Introduction

In Chapter 2, the surveillance loop was identified as a fundamental principal in effective healthcare management. While a significant amount of planning and resources are needed to ensure the collection of good quality data and appropriate analysis of data, it is important to remember that unless the information gathered through surveillance is used to inform policies and work practices, then the surveillance system has not performed its function. In this context, it is important to consider the most suitable and appropriate method of feeding back information to all stakeholders, i.e. closing the surveillance loop.

There are two main considerations when deciding the most appropriate method of feeding back information to stakeholders; what information should be reported and through which medium should this information should be fed back. In the context of an effective surveillance system, it is important to ensure that only the most relevant information is reported. It is possible to generate high volumes of data and data analysis, but if users must search to find the information they require, the usefulness of the surveillance information is diminished.

It is therefore important to carefully choose what data should be fed back to users and how it should be fed back. The literature does not provide a good indication of the optimal solution to these issues and therefore, it was considered an appropriate action to seek to get the views of users of the surveillance system within the hospital setting. An analysis of the views of users would therefore help to ascertain local needs. In addition, the casemix and range of services provided, differs depending on the hospital in question so a local solution may indeed be the most appropriate. Consequently, this chapter will describe a needs assessment that was conducted in a specific Irish hospital setting.

The method employed for the needs assessment was a series of over thirty semi structured interviews. The semi-structured interview is generally defined or described as “a conversation with a purpose” (Kahn & Cannell, 1957). This type of interview allows a framework of various topics and questions to be prepared prior to the interview while giving the interviewer the freedom to add new “ad-hoc” questions during the interview process itself. The interview is, therefore, focused and flexible

but conversational and allows for two-way communication and an exploration of the study subject.

4.2 Methodology

4.2.3 Methodology Selection

A series of semi-structured interviews were considered the most appropriate method for the needs assessment for a number of reasons. It was anticipated that as the diversity of professional groups that would be interviewed would have different priorities. Therefore, in order to record enough detailed information for each of the different priorities, it was felt that a questionnaire would not be an appropriate solution. In addition, focus groups would be difficult to work as, if they were multidisciplinary, it would be difficult to identify key points as each member of the group could conceivably have different issues. If focus groups were carried out with one profession at each group, it would be too difficult to co-ordinate as, in the clinical setting in particular, cover must be available at all times. The advantage of a semi-structured interview was that interviewees would have an opportunity to talk about the relevant areas that were a priority for them. This flexible method of interviewing also allows for the interviewee to seek clarification from the interviewer on questions posed. In addition, it was felt that as this was the first interaction that a lot of staff would have with the surveillance scientist, it would give them an opportunity to see how surveillance was being developed, meet the personnel involved and also have a sense of ownership of the system.

4.2.4 Recruitment for the Interview process

Participants were recruited using the purposive sampling method where the researcher decides which target groups or "key informants" are the most appropriate to provide meaningful and reliable information on the subject under study. The interviewees were chosen, therefore, based on their involvement in infectious disease management and surveillance from within the hospital and wider community setting. The groups or disciplines targeted for interview included hospital consultants, nursing staff, laboratory staff, hospital management, hospital infection control nurses, pharmacy

staff, regional and local public health staff and general practitioners. Potential interviewees were contacted by telephone and asked to participate in this study. At this point, confidentiality was ensured to all participants.

4.2.5 Structure of the semi-structured interview:

Fourteen interviews took place between January and May (2007) among key personnel known to have an interest in surveillance. Following these interviews, the structure of the interview and the list of questions were reviewed and a number of amendments made before continuing with interviews. Where possible, due to changes in the format of the interviews, the first fourteen participants were contacted for clarifications where necessary. A description of the issues discussed during the interviews follows:

Introductions and background:

Each interview began with introductions, as many interviewees had not previously met the interviewer in person. The interviewer then explained the purpose of the interview, highlighting that it was to form part of an M.Sc thesis in Health Informatics in Trinity College Dublin. Interviewees were also informed that the interview would form part of an evaluation of surveillance and infection control activities in the hospital setting, and that an analysis of the interviews would be presented to the Hospital Infection Control Committee.

Part 1. Identifiying the stakeholders/users of the hospital surveillance system.

(a) The interviewee was asked to list their profession and current position.

(b) The interviewee was asked to confirm that they recognised themselves as a stakeholder, or user of the surveillance system

(c) The interviewee was then asked, what other professional groups or key personnel, they would also consider to be stakeholders/users of the surveillance system and therefore should be included in this needs assessment process.

Part 2. Identifying the surveillance information needs of interviewees

(a) The interviewee was asked about the types of surveillance data that would be specific to their work. As much detail as possible was gathered from this question and often, a brief discussion would take place.

(b) Interviewees were asked how they would like the surveillance data they receive to be broken down (e.g. by ward, clinical speciality, by patient cohort etc.)

(c) Users were asked if they would like local data compared to regional or national data where available.

(d) It was also asked if interviewees could identify any data types that were not essential for them to carry out their duties but that would be of interest to them on the basis that it would help them understand some of the broader issues in terms of surveillance in the hospital setting.

(e) Interviewees were asked if, in general, they felt surveillance data was routinely available to them.

Part 3. Identifying the appropriate medium for delivery of surveillance information

(a) Interviewees were asked which was their preferred format for receiving surveillance data. A number of options were put forward including hard copy, e-mail, via a website, notice board, in person or through presentations at committee meetings.

(b) Interviewees were asked how often they would like to receive data

(c) Interviewees were then asked if there were any formats they would particularly not feel were appropriate

Part 4. Identifying previous experience with surveillance systems

(a) The interviewee was asked if they had experience in previous jobs or locations where they had had access to the types of surveillance data discussed in Part 2. Where they answer was yes, a brief discussion took place whereby the interviewee was asked to describe the surveillance system.

Part 5. Identifying opinions of interviewees on how the surveillance system should operate

(a) If not already discussed, the interviewee was asked their opinion on the role of the pharmacy in hospital surveillance.

(b) If not already discussed, the interviewee was asked their opinion on the role of hospital management in hospital surveillance

(c) If not already discussed, the interviewee was asked their opinion on the role of patients in hospital surveillance.

(d) Interviewees were asked to identify any deficits or priorities for improving surveillance in the hospital.

(e) Interviewees were also asked if there were any committees they were involved in or aware of that they thought would benefit from having surveillance data presented to it.

Part 6. Continuing evaluation of the surveillance system

(a) Interviewees were also asked how they would like to give feedback on an ongoing basis to the surveillance team.

4.2.6 Data analysis

Interviews were conducted at a time and place convenient to the interviewee. During the interviews, brief handwritten notes on salient points were taken during the interview and expanded upon after the interview to adequately reflect the opinions of the participant. Appendix 2 shows the data collection form used to take notes. All data from interviews were then typed into Microsoft Word and from there, copied into a Microsoft Excel Workbook for analysis.

4.3 Results

Interviews took place between January and August, 2007. In general, interviews lasted between 15 and 30 minutes in duration. In some instances, not all interview questions were discussed due to the time constraints imposed by the demands of the workload of the interviewee. There were a total of 33 participants interviewed during the course of this study from both the Hospital and Community Setting. All interviews took place on a one to one basis with three exceptions where, due to logistical constraints, two participants were interviewed simultaneously. Information that could potentially identify individuals has been omitted. Results are presented in order of the questions posed during interview.

Part 1. Identifying the stakeholders/users of the surveillance system.

In total, 33 individuals participated in semi-structured interviews. In order to ensure anonymity and facilitate analysis of results, interviewees were categorised under the following headings based on their job/position/role in the hospital or community setting:

- **Allied Health Professionals**. This category included laboratory and pharmacy staff (pharmacists, medical scientists, laboratory managers)
- **Nursing staff** included clinical nurse specialists, infection control nurses, practice development nurses and ward managers.
- **Community**. This category included general practitioners within the catchment area of the hospital being studied as well as practice nurses from the GP services, specialists in Public Health Medicine, Surveillance Scientists and Senior medical officers.
- **Consultants** this category included consultants from the clinical area as well as the laboratory (Microbiologists and Pathologists)
- **Hospital Management**. This included General Managers, assistant operational services managers, director of nursing, finance officers and risk advisors.

A breakdown of the number of interviewees by category is presented in **Table 1**.

Table 4.1 **Total number of interviewees by category**

Target Group	Number of Interviewees
Allied Health Professionals	5
Consultant	6
Hospital Management	7
Nursing Staff	8
Community	7
Grand Total	33

A number of interviewees hold key positions in local, regional and national committees, where infectious disease surveillance is central to the terms of reference of the committees (e.g. infection control committees, SARI committees). All 33 participants interviewed agreed that they were either a user or a stakeholder in relation to surveillance in the hospital setting.

There was a significant amount of variation in terms of interviewees perceptions as to who should be included as users/stakeholders among the 22 respondents to answer this question. For example, while all participants from the community setting agreed that they considered themselves as users/stakeholders, only one participant from the hospital setting mentioned public health or community as a potential stakeholder in this part of the interview. Three groups identified in this part of the interview were not directly included as participants in the survey: Patients, Environmental Health Officers and Hospital Cleaning Staff. Each of these three groups were listed only once during the course of the interviews.

Table 4.2 **Interviewees perception of users and stakeholders in surveillance in the hospital setting**

	Allied Health Professionals	Consultant	Hospital Management	Nursing Staff	Community	Grand Total
Microbiologist	5	4	6	3	2	20
ICNs	5	4	5	3	2	19
Clinicians	4	4	3	4	2	17
Nursing Staff	2	4	5	4	2	17
Medical Scientists	4	2	1	2	2	11
Management	1	2	5	1	1	10
Pharmacy Staff	3	2		2	1	8
Surveillance Scientist	2	1			2	5
GPs	1	1		1	1	4
Public Health	1	1			2	4
Finance Department			4			4
NHO					1	1
Patients					1	1
Cleaners		1				1
EHOs		1				1

Part 2. Identifying the surveillance information needs of interviewees

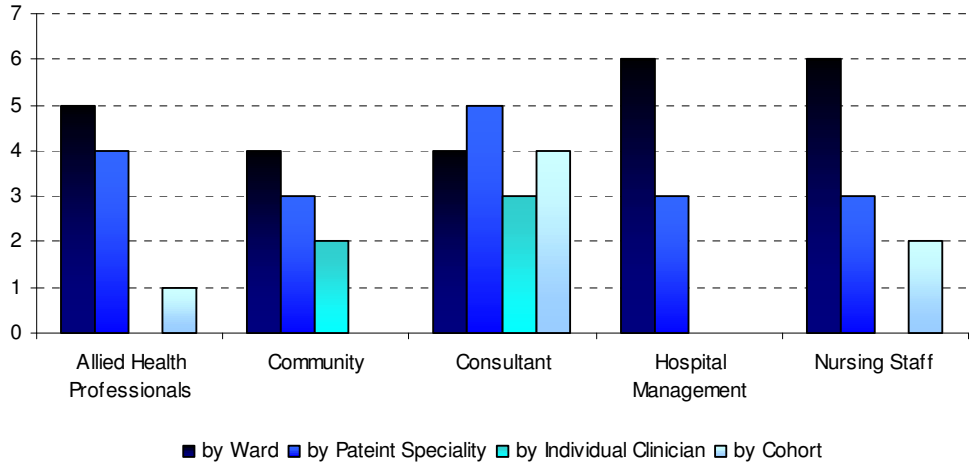
This part of the interview took up the most amount of time to complete and a wide range of priorities were identified. In total, twenty-three types of surveillance information were identified during the interviews. These data are presented in Table 4.3. Figures in brackets represent interviewees who did not feel they needed this information as a priority for their work practices but would be interested in receiving the information.

Table 4.3 **Surveillance information needs of all interviewees.**

Category	Allied Health Professionals	Community	Consultant	Hospital Management	Nursing Staff	Total
Incidence of MRSA/VRE/C. difficile	5	6	6	7	8	32
Incidence of HAI	3	4	6	7	8	28
Incidence rates for all ID in hospital	2	2	3		5	12
Antibiotic Resistance Rates (incl. trends)	3	4 (1)	3	1		11 (12)
Incidence of Norovirus	1		2	2	6	11
Antibiotic Consumption Rates	1 (1)	1 (2)	1 (2)	2 (1)		5 (11)
Rates of positivity in Urine specimens	2	2	2	2	2	10
SSIs	1	1	4	1	2	9
Alerts (outbreaks, meningococcal disease)		2	2	2	3	9
Blood Cultures (including positivity rates)	1		4		2	7
Device Associated Infections		1	1	1	2	5
Antimicrobial Prescribing Patterns	1	0 (2)	1	1		3 (5)
Notifiable Diseases		1		3		4
Risk Factors associated with HAIs	0 (1)	1 (1)			1	2 (4)
Incidence of STIs			2			2
Rates of positivity in swab specimens					2	2
Cost of Anti-microbials	1	0 (1)				1 (2)
Incidence rates for all ID in community	1					1
Negative Results from Screens		1				1
Laboratory testing turnaround times	1					1
Aminoglycoside levels	1					1
Environmental Screening			1			1
Rates of positivity in HVS specimens			1			1

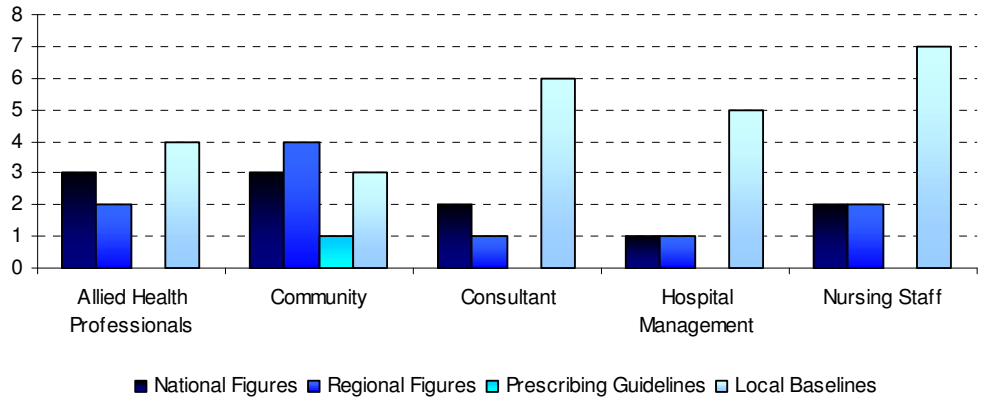
During the course of the interviews, a number of possibilities in relation to how data should be presented were explored. The preferences of interviewees fell into four main groups: by ward, by patient speciality, by individual clinician and by patient cohort. These data are summarised in Figure 4.1. The most popular options identified during interviews were to present data by ward or by patient speciality. A number of clinicians (from the hospital and community) requested that information be reported by clinician also. This was so that individual clinicians could view data for their own patients separately from other clinicians. It was highlighted that this information could be sensitive, so a method of ensuring confidentiality for each clinician should be implemented before releasing this type of data.

Figure 4.1 **Interviewees preferences in how surveillance should be broken down**



Interviewees were asked what types of data they would like included in surveillance reports, if any, in order to evaluate local trends in relation to regional, national or other trends. Four types of surveillance data were identified by interviewees: national data, regional data, how local data compares to current local antibiotic prescribing guidelines and local baselines. These data are summarised in Figure 4.2.

Figure 4.2 **Types of surveillance data interviewees requested to be included in local hospital surveillance reports.**



Seven interviewees felt that they had access to surveillance data at present. Three of the seven interviewees were from the nursing category and four were from the allied health professional category. Five of the seven also indicated that these data were available to them as a result of working closely with the surveillance scientist.

Part 3. Identifying the medium for delivery of surveillance information

There were 33 respondents to this question. Figure 4.3 presents data on the types of format preferred by interviewees as expressed during this interview process. The most popular method for receiving surveillance information was as an e-mail with an electronic document attached. Interviewees felt that it was important for them to have an electronic copy of the report on file and to be able to print off a hard copy from this if necessary. Four interviewees expressed reservations about the use of e-mail for circulating surveillance reports as they would "get lost in the huge volume of junk e-mails" received. These four preferred fax or hard copy as a means of receiving reports.

Figure 4.3. **Format of Surveillance information reports preferred by interviewees**

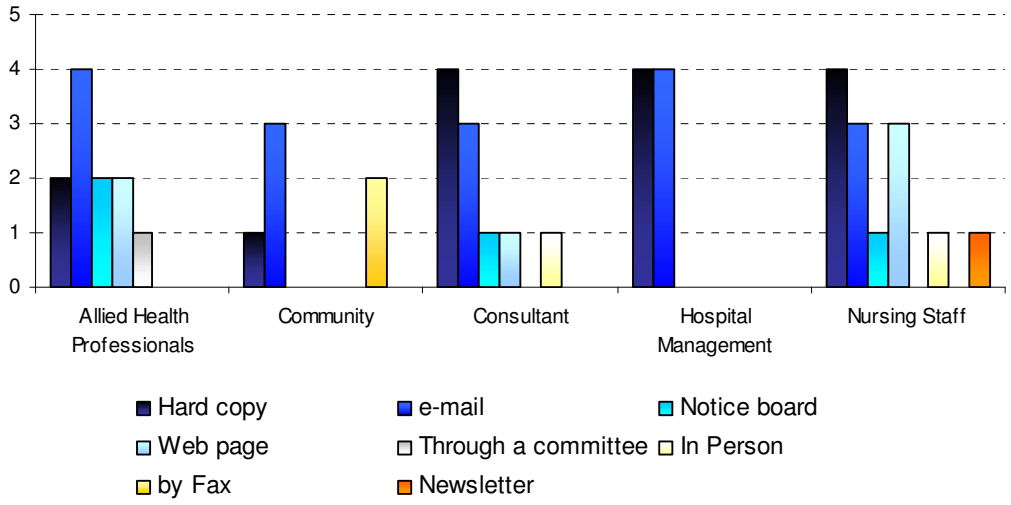
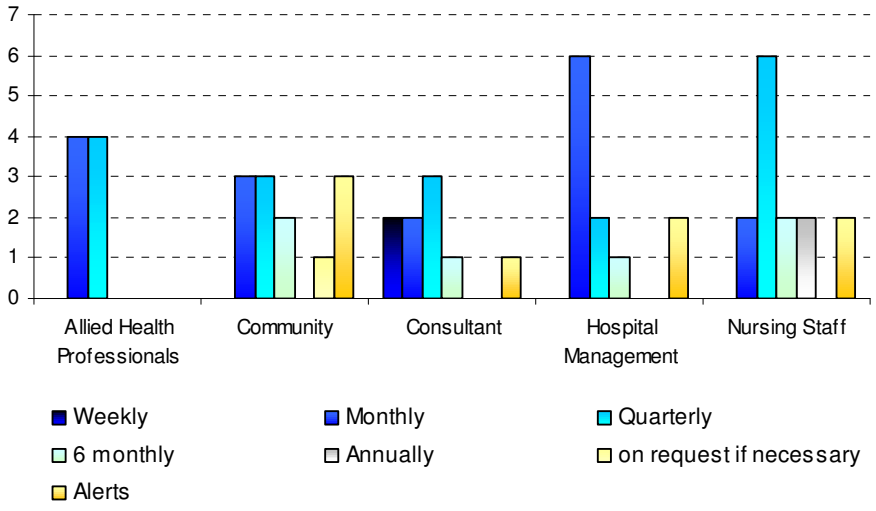


Figure 4.4 presents the frequency of surveillance reporting as requested by interviewees. The majority of respondents said that monthly or quarterly reports would be sufficient depending on the type of data. Respondents felt that monthly reports would not need to include complex data, mainly focusing on incidence rates and general trends. More detailed analysis of resistance rates and antibiotic consumption rates would be suitable for a quarterly or six-monthly report. Eight respondents said that a system for urgent surveillance reports should also be put in place to run in parallel with routine reporting. These alert reports would be issued under unusual circumstances such as an outbreak of meningitis.

Figure 4.4 **Frequency of reporting surveillance information: users preferences**



Part 4. Identifying previous experience with surveillance systems

In total, 7 interviewees said they had previous experience with surveillance systems in hospitals where they had worked previously. Of these seven, five described experiences outside Ireland. In general, surveillance systems described were rudimentary and often focused on specific projects. Interviewees felt that some of the surveillance systems they described had been in their infancy due to the recent recognition of surveillance as an important discipline. One interviewee commented that the information technology infrastructure was more developed in other hospital settings where they had worked outside Ireland.

Part 5. Identifying opinions of interviewees on how the surveillance system should operate

In part five of the interview, an opportunity was afforded to interviewees who had not already done so, to discuss the roles of the pharmacy, hospital management and patients. All respondents said that the pharmacy should be an important component of the hospital surveillance system. Two respondents felt that hospital management should not have access to surveillance data from the community setting as they do not have a role in taking appropriate action. It was also suggested by a number of interviewees that management should not be simply presented with overall figures but that it may be useful to have an interpretation provided by a qualified member of staff (e.g. consultant microbiologist). Interviewees were also asked how they viewed patients' role in the surveillance system. The results of this part of the interview are summarised in Table 4.4.

Table 4.4 **Interviewees opinion on the role of patients in the hospital surveillance system**

	Allied Health Professionals	Community	Consultant	Hospital Management	Nursing Staff	Grand Total
National Direction needed before data is made available	2	1	1	3	4	11
FOI is in place and covers patients need for access to surveillance data	1	3	2	1	1	8
Patients should have access to surveillance data	1	1	1	1		4
Patients should not have access to surveillance data		2			1	3

Top priority for surveillance

When asked if interviewees could identify a priority area where they would like to see action in the short term, four general areas were highlighted. The development of a formal hospital antibiotic usage policy was the only area highlighted by members of all five categories. Table 4.5 summarises the opinions of interviewees on how priorities should be set in developing the hospital surveillance system.

Table 4.5: **Top priority for surveillance as identified by interviewees**

	Allied Health Professionals	Community	Consultant	Hospital Management	Nursing Staff	Grand Total
Lack of Hospital Antibiotic policy	4	2	2	1	2	11
Difficulty in accessing data			1	4	2	7
Lack of Communication/Feedback	1	2			1	4
Deficiencies in IT infrastructure (incl. LIS)		1	1	1		3
Lack of clinical details for Lab tests			1			1
Lack of Isolation facilities in the hospital					1	1
Lack of availability of notification booklets		1				1
Timeliness of ID notifications		1				1
Grand Total	5	7	5	6	6	29

In part 5 of the interview, respondents indicated a number of committees where they felt surveillance data would be useful. For presentation purposes, the list of committees has been divided into local hospital committees (Table 4.6) and regional committees (Table 4.7).

Table 4.6 Hospital Committees to which hospital surveillance data should be available

	Allied Health Professionals	Community	Consultant	Hospital Management	Nursing Staff	Grand Total
Hospital Infection Control	4	2	5	4	6	21
Hospital Drugs & Therapeutics	1	1	3	2	1	8
Quality and Risk Committee		1	2	3	1	7
Laboratory Management Team	3		2			5
GP Hospital Liaison Group		2			1	3
Hospital Hygiene Committee				1		1
Hospital Decontamination				1		1
Hospital Medical Board			1			1
Nursing Administration Meetings				1		1
Corporate Hygiene Services					1	1

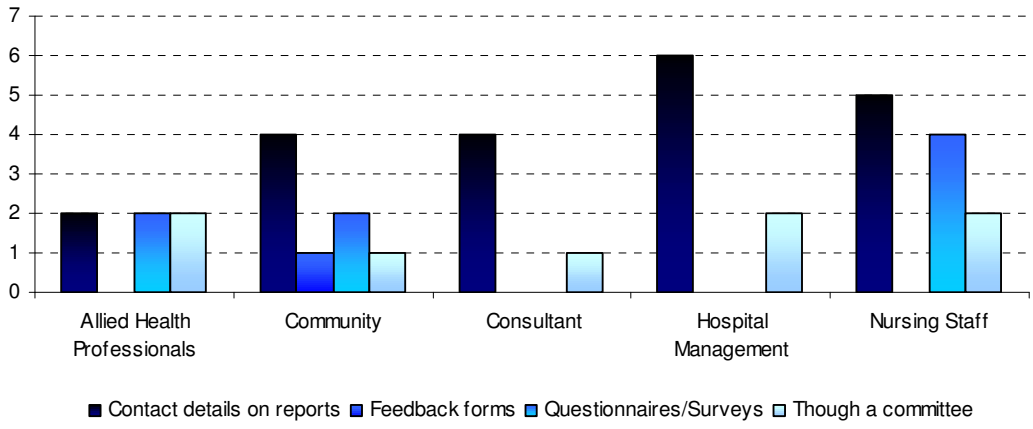
Table 4.7 **Regional Committees to which hospital surveillance data should be available**

	Allied Health Professionals	Community	Consultant	Hospital Management	Nursing Staff	Grand Total
Regional Infection Control		3	1		2	6
Regional SARI Committee	1	2			1	4
Regional CIDR Users Group		2				2
Regional Infectious Disease		2				2
Regional Zoonoses Committee		2				2
Regional Clinical Network	1					1
Regional Management		1				1
CAWT Management		1				1

Part 6. Continuing evaluation of the surveillance system

The last part of the interview was intended to capture surveillance system users preferences for how they would like to feed back comments or queries to the surveillance team on an ongoing basis. The most popular method for feedback was to provide contact details for an individual at the end of all reports. One interviewee pointed out that this would lead to a negative bias in feedback as, from experience, users generally only provide feedback when they encounter a problem. A number of interviewees felt that, in the future, it might be useful to repeat the needs assessment either as interviews or perhaps more suitably as questionnaires or user satisfaction surveys. Figure 4.5 summarises these data.

Figure 4.5 **Feedback mechanisms for the surveillance system as preferred by interviewees**



Other issues that were highlighted during the interview process

Appropriate Action

A number of interviewees commented that, when surveillance information is available, responsibilities for taking appropriate action need to be clearly defined. One interviewee also commented that "surveillance data can be a good indicator of practice going wrong"

HAI in the community setting

One interviewee from the community setting highlighted hospital acquired infection as an important area where surveillance should be undertaken and pointed out that hospital acquired infection is a problem in the community setting also.

Timeliness of Surveillance data

One interviewee highlighted a problem in relation to delays in notification where clinicians suspected a notifiable disease but awaited laboratory confirmation before notifying public health.

Integration with existing work practices

Several interviewees raised the issue of how surveillance should be incorporated into existing education sessions for nursing and medical staff.

4.4 Discussion:

4.4.1 Introduction:

This chapter has described for the first time, the views of a broad spectrum of healthcare workers on their requirements for infectious disease surveillance information in an acute hospital setting. The semi-structured process provided a flexible methodology that captured an appropriate data set in order that surveillance priorities can be set going forward. The following section presents a discussion of some of the key findings of the interview process.

4.4.2 Overview of Findings

Part 1. Identifying the stakeholders/users of the hospital surveillance system.

As has been demonstrated in this thesis, surveillance is very much a multidisciplinary activity. While it was difficult to ensure that a representative number of individuals from all relevant professional groups were interviewed, the fact that interviews that took place late in the process did not reveal new information suggests that the needs assessment was representative.

When discussing who the stakeholders are in hospital surveillance, patients, environmental health officers (EHOs) and cleaning staff were each mentioned once only. These three groups however were not included in this study for a number of reasons. It was felt that ethical issues prevented patients from being asked to participate in this exercise, and it was also difficult to see an appropriate avenue through which comparable data might be obtained. Cleaning staff are employed on a contract basis through management, and it was felt that issues relating to cleaning in the hospital setting were covered through interviews with hospital management. EHOs are not employed in the hospital setting and would have been included in the community group, but time did not allow for suitable interviews to take place within the timeframe of this thesis. Ideally, EHOs should be consulted to assess their needs in terms of surveillance from the hospital setting in the future.

It is not surprising that the most frequently recognised stakeholders in surveillance included the Consultant Microbiologist and Infection Control Nurses as these professionals regularly provide surveillance information for clinicians, nursing staff and hospital management. In contrast, only five interviewees included the surveillance scientist. This may indicate a lack of awareness of the role of the

surveillance scientist at a hospital level among many health professionals. Indeed, Surveillance Scientists are a relatively new addition to the ranks of allied health professionals in the hospital setting and their role can vary greatly from hospital to hospital.

Part 2. Identifying the surveillance information needs of interviewees

Twenty-three different types of data were identified by respondents as key surveillance information they would like to have access to. In particular, MRSA, VRE, *C. difficile* and Hospital Acquired Infection rates were cited most frequently during interviews. In most cases, it is not mandatory to notify these infections to public health under the current legislation (the exceptions being invasive MRSA ad invasive VRE). This has resulted in a lack of reliable surveillance information being available to clinicians from other sources (e.g. existing weekly surveillance reports issued by HPSC). As a result, in the hospital setting, staff are reliant on local surveillance systems for accurate data relating to these infections.

Surveillance Requirements by Category of Interviewee

As a group, Hospital Management were particularly interested in rates of MRSA, VRE, *C. difficile* and hospital acquired infection. This is mainly due to the burden on the system in terms of extra cost, isolation facilities, bed days and staffing requirements that these infections incur. Due to the media attention these organisms have received in recent years, there is also a greater demand from high-level management for surveillance information to satisfy freedom of information requests and parliamentary questions. Furthermore, there is significant interest in using incidence of these organisms as a performance indicator for infection control in the health service and hospitals in general. With these points in mind, hospital management have a keener interest in surveillance data than ever before.

Hospital Consultants as a group highlighted rates of MRSA, VRE, *C. difficile*, hospital acquired infection, surgical site infection rates and blood culture surveillance as surveillance data priorities. As described in Chapter 3, surgical site infection is often used as a measure of the effectiveness of infection control. It was generally felt that surveillance data of this type would allow identification of problem areas within the hospital and would provide an evidence base for the introduction of interventions and changes in infection control practices.

Nursing staff expressed a particular interest in rates of Norovirus (also known as the winter vomiting bug). Although Norovirus causes a short term illness with few complications, it can cause severe disruptions in the healthcare setting among both patients and staff. It is therefore not surprising that nursing staff felt that surveillance information on Norovirus is particularly important.

GPs, nursing staff and hospital consultants were interested in the rates of positivity for certain sample types (e.g. Central Stream Urines, swabs etc.). This would be important in terms of evaluating laboratory testing algorithms used in the clinical area. This data would ideally show trends over time but if possible, it would be interesting to see if there were differences among patient groups (e.g. is there a lower rate of positivity in samples from pregnant women due to increased testing).

Interviewees from both the hospital and community group highlighted the need for information on antibiotic resistance rates. These data are particularly important in relation to modifying empiric community and hospital antibiotic prescribing guidelines for local use. Resistance rates to antibiotics among key organisms (*E. coli*, *Enterococcus spp*. etc.) were of particular interest. In general, resistance rates were viewed by users as a specialised type of data, of particular interest to Consultant Microbiologists in order who would use the data to adapt generic antibiotic reporting policy for local use. Three other types of data relevant to antibiotic stewardship were also identified during this part of the interview. Antibiotic consumption rates, antimicrobial prescribing patterns and costs of antibiotics were identified as data types that could potentially act as indicators of the effectiveness of antibiotic stewardship.

The need for a system of reporting significant events was also highlighted in a number of interviews. For example, outbreaks of any nature or the identification of meningococcal cases were highlighted as events that would warrant an alert being issued by the surveillance team to all relevant personnel. In the case of meningococcal disease, an alert to all GPs in the geographical area where the case was identified was suggested.

In general, there were a lot of similarities between the interviewees in terms of their surveillance needs. However, it must be recognised that there will often be a need to accommodate quite specific requests for data that may only be of relevance for one user/stakeholder.

Format of the Data Required

During interviews, the issue of how data could be broken down in a meaningful and useful way was discussed. While general aggregate numbers were sufficient for some users (e.g. Management), the vast majority of interviewees expressed a preference surveillance data to be de-duplicated by patient. This reduces bias resulting from patients who are repeatedly tested.

GPs requested that data be broken down by GP Practice and reported in confidence to each practice. As a context, how each practice compares to the average of all practices would be desirable along with some comparison or comment regarding the current community antibiotic prescribing policy. In contrast, Hospital Consultants preferred data broken down by speciality under which the patient was admitted. A number of clinicians also requested that they receive a breakdown of data for the patients under their care. Concern was expressed that this may facilitate league tables and so clinicians requested that these data be presented in a manner that ensured confidentiality and anonymity. Nursing staff were interested in data broken down by ward but similar to clinicians, would like data to be confidential in terms of a league table of wards. In general, wards specialising in care for specific sets of patients felt that the ward was an appropriate means of presenting data (e.g. ICU). Where patients from different specialities were cared for on the same ward, interviewees requested that data be broken down by patient speciality (e.g. elective surgery). Finally, a number of interviewees requested that data be presented for certain cohorts of patients that may access services in a range of clinics or wards (e.g. cystic fibrosis patients)

Comparison with other Data

For meaningful interpretation of surveillance data, it can be useful to include comparable data from other sources. Interviewees were asked what types of information they would like to have included in surveillance reports for comparison with local data. In general, local baselines were the most popular type of data requested. It was highlighted to interviewees that the surveillance system may need to operate for a length of time before baseline data can be gathered. Comparisons with Regional and National data were also a common request but it was pointed out that these are usually only available for notifiable diseases. For example, weekly reports on infectious disease notifications, outbreaks and influenza surveillance are issued by HPSC. In addition, EARSS reports are issued by HPSC on a quarterly basis.

Current availability of surveillance data to users

The majority of users felt that a formal system of dissemination of surveillance data to users was not in place. In practice, the surveillance scientist receives *ad hoc* requests for data, mainly through the consultant microbiologist, medical scientists, infection control nurses and hospital management, and reports are issued through the hospital infection prevention and control team. It is therefore not surprising that a low number of interviewees (7 out 33 in total) felt they had access to surveillance data at present and the majority of those who did, worked closely with the surveillance scientist.

This needs assessment was designed to address issues users have in relation to access to surveillance data and to formalise the development of a reporting/feedback process in the hospital setting. By so doing, in future user satisfaction surveys, it is hoped that this question in particular will be answered differently.

Part 3. Identifying the medium for delivery of surveillance information

Part three of the interview was designed to investigate preferences in terms of the format and frequency of surveillance reporting. Printed hard copies and e-mail with electronic documents attached were the most popular choices among all categories of interviewee. However, not all users favoured e-mail as a tool for disseminating surveillance information. Although it may seem that hard copies of reports would not be necessary in a work environment with significant information technology resources, a number of interviewees pointed out that in the hospital structure, not all staff have access to e-mail. This is partly due to minimising costs of licensing communications software. In this context, notice boards were suggested as a possible way of making surveillance reports more accessible to all staff. However, it was pointed out that surveillance reports may contain confidential or sensitive information and it would not be appropriate to have such information viewable by members of the public or by patients. Another interviewee proposed that notice boards may be suitable in areas of the hospital where there is restricted access, such as the laboratory. A small number favoured other communication alternatives such as delivering surveillance data in person or through a committee. These methods may not be suitable due to the time demands this would place on staff involved in surveillance. One interviewee pointed out that a website with restricted access may be an appropriate and useful way to have access to surveillance reports, and particularly to

archived surveillance reports. Finally, fax was specified as a means of communicating surveillance reports by two interviewees. The issue with fax, however, is that it would be difficult to ensure confidentiality of information, as fax machines are often in shared office space where access to fax printouts may not be secure. In fact, a policy of not using fax for communicating confidential laboratory reports containing patient information currently exists within the hospital.

Newsletters were also described as a potential method of communication. It was pointed out that a surveillance newsletter was already produced by public health for the community setting. It was proposed that community data from the hospital could be incorporated with other public health surveillance data in the same newsletter thereby avoiding duplication.

Frequency of Reporting

In terms of frequency of reporting, the most important consideration is to ensure that resources are in place to maintain the frequency set out when introducing the surveillance system. A balance is necessary in order to ensure that reporting is not too frequent so that it puts strain on the resources of the surveillance team, but needs to be frequent enough to provide timely information for users and stakeholders. The majority of interviewees expressed a need for receiving basic data on a monthly basis. These basic data would include the incidence of notifiable diseases, organisms of relevance to infection control such as MRSA, VRE and *C. difficile* and rates of positivity for specimen types. Interviewees expressed a need for more complex data on a less frequent basis such as quarterly or 6-monthly. These data types could include antibiotic resistance rates, antibiotic consumption rates and rates of Hospital Acquired Infection. This differentiation would be prudent for a number of reasons. The types of data issued monthly as per the scenario outlined by interviewees, would largely be generated from existing computer system, thereby simplifying data collection. In contrast, data types such as resistance profiles are complex by nature and a significant amount of data processing would be necessary before these data are in a format that can be easily interpreted. In addition, data from a number of consecutive months would need to be analysed simultaneously in order to generate sufficient data to accurately identify trends.

Part 4. Identifying previous experience with surveillance systems

During the design of the semi-structured interview, it was hypothesised that the previous experience of interviewees with other hospital surveillance systems would be a useful source of information. In particular it was hoped that users would identify positive and negative aspects of hospital surveillance systems. However, in practice, a small minority of interviewees had worked in other settings where a hospital surveillance system was in operation. There are a number of possible reasons contributing to this lack of experience with regard to surveillance in other settings. Surveillance itself is a relatively new discipline and its profile in different healthcare settings can vary greatly. Furthermore, many of the professionals interviewed had been in their current positions for a number of years..

This part of the interview proved to be the least effective in terms of gathering the information as intended during the design of the interview. Nevertheless, it did emphasise how new this type of surveillance information is in the hospital setting, at least in Ireland. However, this section of the questionnaire is unlikely to provide any extra useful information if the survey was to be repeated in the same hospital setting.

Part 5. Identifying opinions of interviewees on how the surveillance system should operate

Part of the motivation for carrying out this needs assessment was to gain an insight into what kind of surveillance data stakeholders would want to have access to in the hospital setting and also to clarify individual preferences on how the surveillance system should operate within the hospital. These preferences not only related to interviewees own interaction with the surveillance system but also, to how the surveillance system would interact with each of the professional groups and existing structures within the hospital.

Although Part 1 of the interview did not rank pharmacy staff high on the list of stakeholders, Part 5 of the interview confirmed that pharmacy staff were a key stakeholder in surveillance in the hospital setting. This is not surprising as antibiotic stewardship is a key activity in preventing the emergence of antimicrobial resistant organisms. In addition, a number of interviewees had identified data types relating to antibiotic stewardship as key surveillance information they would like to access. This part of the interview therefore highlighted the need to foster close links between the pharmacy and the infection control team. Under the current structure in the hospital, the infection al control team consists of the Consultant Microbiologist, Infection Control Nurses and the Surveillance Scientist. Where necessary, a representative from nursing practice development also forms part of this core group. It would therefore be beneficial for a representative of the pharmacy to become part of this core infection control group. In 2007, a number of hospital anti-microbial pharmacist positions were approved by the HSE. It may be that this professional would be an appropriate candidate for inclusion in the infection control team.

Although Hospital Management were recognised in part one of the interview as being a key stakeholder in surveillance in the hospital setting, further discussion in Part 5 of the interview revealed one area where it may not be appropriate for hospital management to have access to data. Although the hospital laboratory provides a service for public health and general practitioners, hospital management are not involved in management structures in the community. It is therefore not necessary for hospital management to receive detailed surveillance reports relating to the community. As the emphasis on the HSE transformation program focuses on integrated care and bridging the gap between the acute hospital and community

services, it may be that a management structure in the future would incorporate both hospital and community services.

Up to this point in each of the interviews, many interviewees had not included patients as being part of the surveillance system within the hospital. The issue of the interaction between patients and the healthcare system in relation to surveillance data was discussed in part 5 of the interview. In general, interviewees acknowledged the need for patients' interests to be represented. Although information is available to the pubic and the media in Ireland through Freedom of Information legislation, there have been suggestions that hospitals routinely release or publish their MRSA and HAI rates. This approach to the need for information by the public has been in place in the UK since 2001 with mixed outcomes. Because of this, some respondents to the interview expressed concern over being the first hospital in Ireland to make surveillance information freely available and felt that a national direction was needed so that surveillance information would be standardised and comparable between hospitals decreasing the risk of misinterpretation. It was also felt that there would be negative media attention should any hospital release MRSA, VRE or HAI rates without national direction. Indeed, three interviewees felt that surveillance data should not be released to patients as it is a complex issue and only leads to "hysteria" which may prevent patients from seeking appropriate medical treatment. One interviewee, however, emphasised how media pressure should be ignored and that "the bottom line is professional responsibility".

An interesting suggestion emerged during one interview where it was proposed that a patients' representative be invited to participate in a hospital committee structure where issues relating to surveillance and infection control would be discussed. The advantage here would be that a context for surveillance data would be included rather than just the releasing of crude figures.

Priorities for surveillance

A key aspect of this needs assessment was to set priorities for action in the future. This part of the interview identified 4 key priorities from the users perspective: absence of a formal antibiotic policy for the hospital, clarification on the structures in place for surveillance and infection control activities, accessibility of surveillance data and investment in ICT. The most interesting aspect of this part of the survey was that each of these issues had already been identified in the hospital and a number of

initiatives are in various stages of completion in order to address these deficits. For example, a hospital antibiotic policy is due to be launched in November 2007, terms of reference have been developed for the infection control committee and there have been major investment in ICT which will culminate in the introduction of a ward look up system for the hospital. However, users of the surveillance system did not appear to be aware of many of these plans highlighting the need for better communication between users of the surveillance system and the surveillance team.

Availability of Surveillance data to local and regional committees

During interviews, users were asked if there were any committees, either local or regional that they felt would benefit from having access to local hospital surveillance data. Apart from the Hospital Infection Control Committee, the need for the Drugs and Therapeutics committee to have access to data was highlighted given their involvement in antibiotic stewardship. The importance of a close link between the hospital infection control committee and the drugs and therapeutics committee has been recognised, and as a result the chair of the infection control committee also sits on the drugs and therapeutic committee.

In all 10 local and 8 regional committees were identified in this part of the interview. It is intended that a letter be sent to each of these committees to ask specifically what types of surveillance information they would like to be made available to them.

Part 6. Continuing evaluation of the surveillance system

Incorporating a mechanism for users to feed back to those providing surveillance data is an important consideration when introducing a surveillance system. It recognises that surveillance systems must be flexible and be able to adapt to the changing needs of users. In addition, a feedback mechanism would also give users a sense of ownership and inclusion in the surveillance system. All interviewees felt that they would need to know how to contact those producing the surveillance data. The majority suggested that contact details of an individual contact person at the bottom of each report would be sufficient. A number of interviewees felt that a survey or questionnaire similar to the semi-structured interviews conducted as part of this thesis would be beneficial. These surveys could take place approximately a year after the

introduction of the surveillance system. This would give users an opportunity to become familiar with the system and how surveillance data impacts current work practices.

4.5 Conclusions:

The format of the semi-structured interview worked well and provided much of the information the needs assessment process was designed to capture. In addition, a number of unexpected and novel ideas were identified during the process. The number of interviews conducted was appropriate given that interviews conducted towards the end of the process did not identify new ideas or viewpoints that had not already been discussed by other interviewees.

A number of common surveillance goals emerged during the interviews, many of which applied to all categories of interviewee. In general, incidence of all infectious disease, antibiotic resistance profiles and antibiotic consumption rates met the needs of a wide number of personnel. Within the hospital setting where the interviews took place, these types of surveillance data are available but this interview process has highlighted the need to communicate the data more effectively with users and stakeholders.

A number of more detailed surveillance modules such as SSIs, Blood culture surveillance and device-associated infections surveillance were also identified during the interviews. With the exception of blood culture surveillance, these types of data are not currently being collected in the hospital setting in question. It is clear that in the future, these types of surveillance should be considered for implementation. Furthermore, it is a key element of formalising surveillance structures within the hospital that the surveillance system be a scaleable solution. Not only should the surveillance system encapsulate all surveillance activities currently underway in the hospital, but also, they system should be able to incorporate new surveillance modules in the future.

In terms of reporting, users emphasised the need for trend analysis and inclusion of comparable statistics from local and other sources. Inclusion of such complementary data in reports will greatly enhance the usefulness of local

surveillance data, and allow for more clear interpretation by users. In general, targeting reporting would seem to be preferential among users.

Overall, this exercise has been extremely useful in gathering valuable information on users needs for surveillance in the hospital setting. This information comes at an opportune time also, as a number of surveillance initiatives for hospitals are being developed at a national level. In quarter 3, 2007, the HPSC began a pilot of MRSA surveillance in ICUs. In addition, the National Hospitals Office have emphasised the need for anti-microbial consumption data at a national level as well as recognising the importance of the EARSS surveillance system which has been operating in Ireland for a number of years. In order to ensure that the maximum benefit is realised from this interview process, a number of surveillance priorities have been set. In addition, Chapter 5 collates some of these data and proposes a surveillance system structure that meets the needs of all users.

Chapter 5

5.1 Introduction

This thesis began by describing surveillance as a discipline and emphasising the contribution it can make to improving patient care in the hospital setting. In Chapter 3, a number of nosocomial surveillance systems were described and compared. Specifically, data items collected for Bloodstream Infection surveillance, SSI surveillance and ICU surveillance were discussed. Chapter 4 summarised the findings of a needs assessment in terms of hospital surveillance in a specific hospital setting in Ireland. Chapter 5 takes some of the information from Chapter 4 and 3 and uses it to demonstrate how a surveillance system can be structured in order to meet the needs of all users.

5.2 Methodology

In order to design a structure or architecture for an effective surveillance system in the hospital setting, a reverse engineering process was employed. The surveillance requirements identified by users and stakeholders in Chapter 4 was translated to system outputs. An analysis of the data items required in order to deliver these outputs was conducted. This information was then used to identify all necessary inputs to the surveillance system. This information was then used to design a surveillance structure that incorporated all inputs and desired outputs. Finally, in order to ascertain if the model proposed represented a scaleable solution, data from Chapter 3 was used to evaluate the flexibility of the surveillance system.

5.3 Results

5.3.1 Data Outputs

Following analysis of the data gathered in Chapter 4, the following series of reports were designed to provide users of the surveillance system with the ten most frequently requested surveillance data items. These report formats also incorporated data relating to frequency of reporting and method of dissemination of surveillance information.

Monthly surveillance summary report:

A monthly surveillance summary report should be issued to the Hospital Infection Control Committee (HICC), the laboratory management team (LMT) and the HIPE department. From the infection control committee, it would be disseminated to clinicians, wards, pharmacy, management and the Quality and Risk committee. The data included in this report would comprise Incidence rates of all infectious disease reports from the hospital setting (including trends) and incidence of HAI (including trends). This report would be broken down by ward and by patient speciality.

Quarterly Surveillance Report:

This report would be circulated to the HICC and the LMT. From the infection control committee, it would be disseminated to clinicians, wards, pharmacy, management and the Quality and Risk committee. The report would comprise trends in resistance rates for a selection of clinically significant organisms which could initially include *E. coli*, *Klebisella spp*., *Staphylococci*, *Streptococci* and *Pseudomonas* species. The analysis would be presented as the 1st isolate per patient per quarter in line with common reporting practice for AMR (NCCLS, 2002; EARSS protocol). Once baselines have been gathered trends in resistance rates could also be included in this quarterly report. It would be worth while to collaborate with the pharmacy department in the hospital to collect corresponding antibiotic consumption rates for each quarterly report. Once established in the hospital the quarterly surveillance report could be used to present information from Enhanced Blood Culture, SSI and ICU Surveillance projects. Finally, as requested by some users, rates of positivity for all specimens submitted to the laboratory from the hospital setting (swabs, urines etc.) could be incorporated in the quarterly report.

Quarterly reporting to HPSC

Three types of surveillance data are forwarded to HPSC on a quarterly basis. Both EARSS and enhanced EARSS data are currently sent to HPSC at the end of each quarter (Enhanced EARSS is a complimentary data set to EARSS and summarises data on clinical significance and risk factors). Both of these surveillance datasets are submitted to HPSC on surveillance forms. Data relating to surveillance of MRSA in ICUs is also submitted to HPSC on a quarterly basis as a Microsoft Excel Spreadsheet.

Quarterly reporting to regional SARI committee

As the hospital laboratory processes GP and nursing home samples it is essential that an analysis of this community data be conducted. Owing to the workload already involved in establishing a hospital surveillance system, it is proposed that an anonymised deduplicated dataset containing the first isolate per patient per quarter for all Nursing and GPs samples be forwarded to the Regional SARI committee. This dataset could include all pertinent laboratory data including organism identified and resistance profiles. It would then be the responsibility of the Regional SARI committee to identify a key person in the community setting to analyse this community surveillance information. Ideally, as suggested during interviews in Chapter 4, these data would be incorporated into an existing surveillance newsletter published by regional public health.

Together, these four outputs would represent the majority of surveillance information requests as described in Chapter 4. In terms of method of circulation of these reports, it is proposed that, in the short term, both an e-mail and hard copy distribution system be put in place. Over time, depending on individual preferences, e-mail and hard copy mailing lists can be updated to reduce duplication.

5.3.2 Data Inputs

In order to ensure that all the necessary data is collected for the reports listed in 5.3.1. an analysis of the individual data items for each report was performed (data not shown). All data items identified may be collected from one of 5 sources or 'inputs'

1. Hospital laboratory information system
2. Pharmacy paper forms and the pharmacy computer system
3. Surveillance forms
4. Hospital Information System
5. Hospital Inpatient Enquiry Office

The Hospital Laboratory Information System (LIS or LIMS)

The laboratory information management system stores data from three main sources: demographic patient information is downloaded from the Hospital Information system via a one-way interface; details of the laboratory test request are manually entered on the LIS from request forms submitted to the laboratory; Laboratory test results are entered on the system in two ways, manually by medical scientists and automatically from automated laboratory instruments via a two-way interface. A query tool is in place to extract data from the laboratory information system.

Document M-39A describes CLSI guidelines on the functionality of the Laboratory System in relation to storing resistance profile data (NCCLS, 2003). As a first step in identifying if useful surveillance information is stored appropriately in the LIS, a comparison of the LIS with the CLSI guidelines was performed. This data is included in Appendix 4.

Pharmacy data

Pharmacy data in the hospital in question is stored in two ways. Antibiotic consumption data is available through the pharmacy computer system. These crude statistics record the amounts of antimicrobials used on each ward. In the hospital under review, the pharmacy has a stand alone IT system with no interfaces with other systems. Paper forms recording individual prescriptions for patients are also stored in patients charts or nursing notes. These forms record dose, frequency and duration for each antimicrobial prescribed.

Surveillance Forms

Surveillance forms are a fundamental component of most effective surveillance systems. Hard copy forms provide a medium for data from a wide range of sources to be recorded together. For example, the primary method of data collection in the Blood culture, ICU and SSI surveillance systems described in Chapter 3 are by means of surveillance forms (see Appendix 2 for sample forms).

In order to make forms as user-friendly as possible, standard definitions for each data item should be agreed and should be readily available to all users. Several commercial software packages such as Teleform and Formic are frequently used in hospital surveillance in Ireland. These packages provide surveillance personnel with a number of key functionalities. Firstly, forms can be designed in the software package.

Secondly, when producing forms from the software, data already available in the surveillance database can be automatically filled in on individual forms when printing. Thirdly, completed forms can be scanned in, data processed using optical character recognition and finalised data exported to a surveillance database.

Hospital Information system

The hospital information system contains patient demographic data, episode data and other information relating to patients' interactions with the hospital service. The system in place in the hospital setting where the study took place is a commercially available software package supplied by iSOFT.

HIPE Data

The Hospital Inpatient Enquiry System is managed by the HIPE and NPRS Unit of the Economic and Social Research Institute (ESRI) and represents a valuable source of standardised morbidity data available in Ireland (HIPE, 2007). The aim of the system is to collect, from patient medical charts, demographic, clinical and administrative information on each episode of hospital care. Data is coded according to the International Classification of Diseases (ICD) 10^{th} Revision, Clinical Modification. In terms of surveillance, the HIPE data collected at hospital level is the most complete source of denominator data available. Among other figures it is possible to obtain numbers for total admissions, number of surgical procedures and number of bed days by ward. Clearly this is an important component of the surveillance system.

5.3.3 A Surveillance System Architecture

Given the set of data inputs and outputs described in section 5.3.1 and 5.3.2, Figure 5.1 summarises a proposal for a hospital surveillance system structure designed to meet the needs of all users.

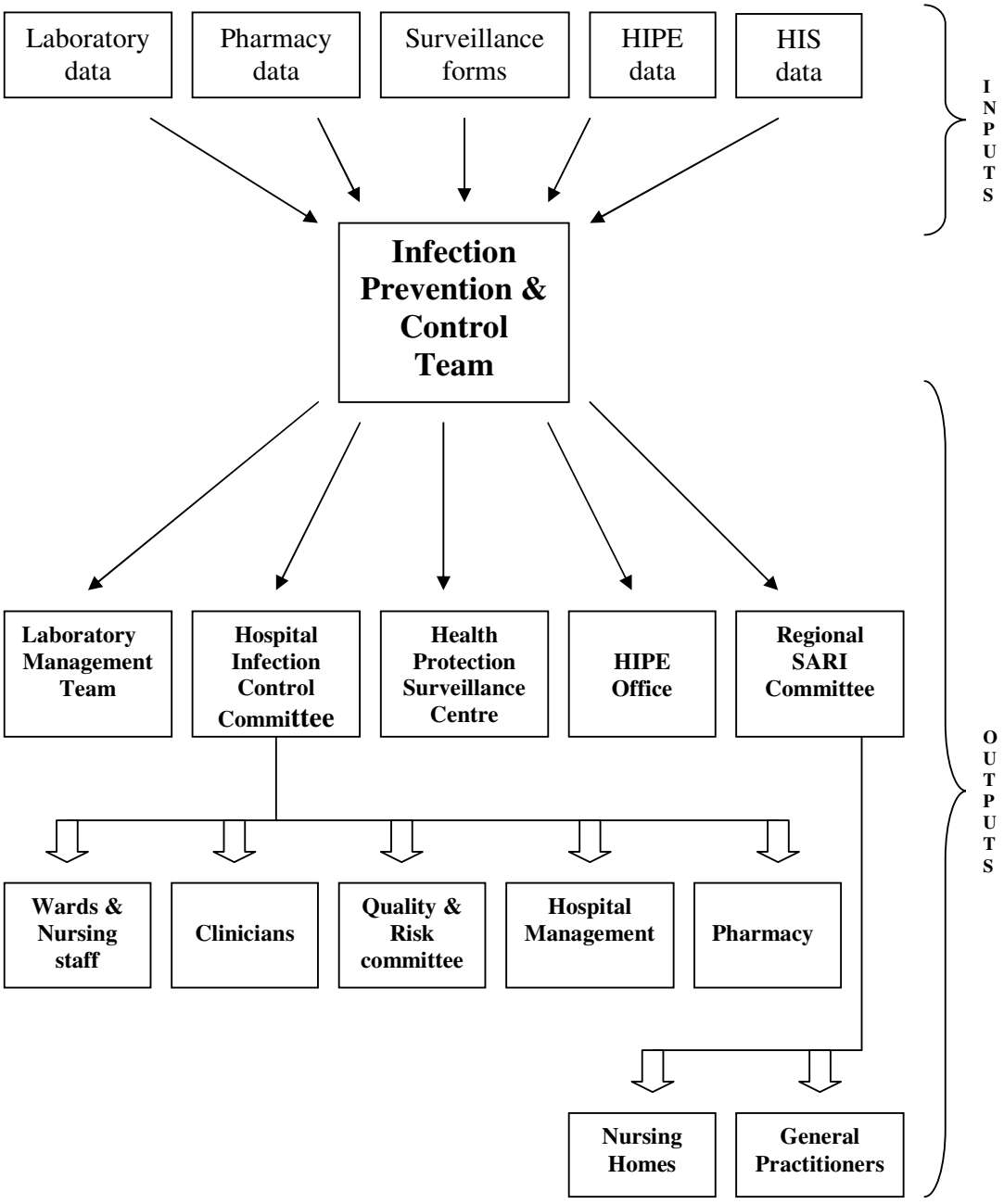


Figure 5.1 Overview of a surveillance system structures in an Irish hospital setting

5.3.4 Evaluation of the scalability of the proposed surveillance system

When proposing a structure for a hospital surveillance system, it is important as far as possible to ensure a scaleable solution is provided. In Chapter 4, a number of interviewees expressed an interest in SSI surveillance and Bloodstream infection surveillance. In addition, in 2007, HPSC have initiated a rudimentary ICU surveillance system for MRSA. In order to ensure that these can be added to the surveillance structure proposed in Figure 5.1, datasets from Chapter 3 relating to ICU, bloodstream infection and SSI surveillance were examined to ascertain if the individual data items necessary to carry out these types of surveillance could be incorporated into the existing surveillance model within the hospital.

Three types of data item were categorised in chapter 3: patient/hospital detail, infection detail and event detail. Appendix 5 presents a full list of all data items pertaining to ICU, bloodstream infection and SSI surveillance and describes where each individual data item may be collected in the hospital surveillance system. These data are summarised in Figures 5.2, 5.3 and 5.4.

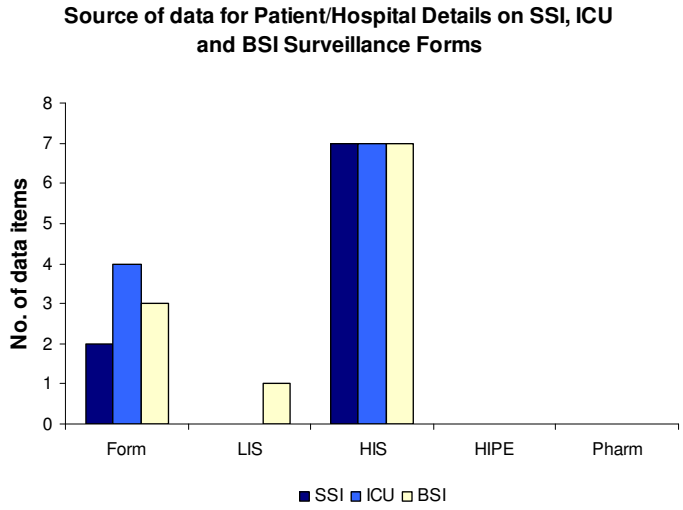


Figure 5.2 Sources from which individual data items relating to Patient/Hospital detail may be collected in a hospital surveillance system

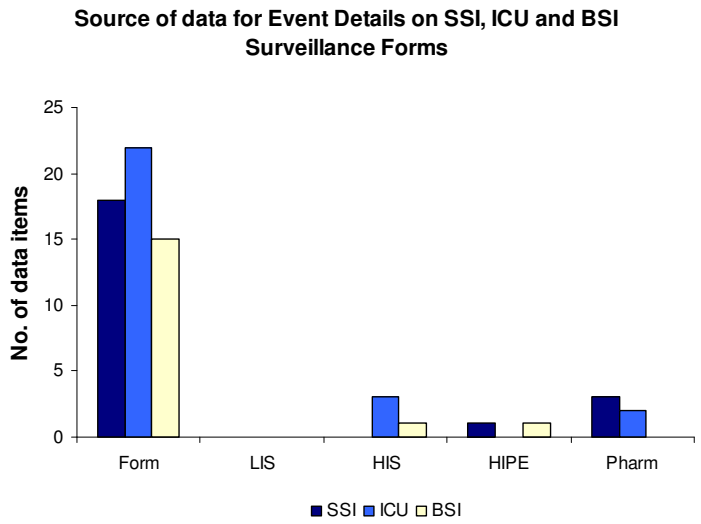


Figure 5.3 Sources from which individual data items relating to Event detail may be collected in a hospital surveillance system

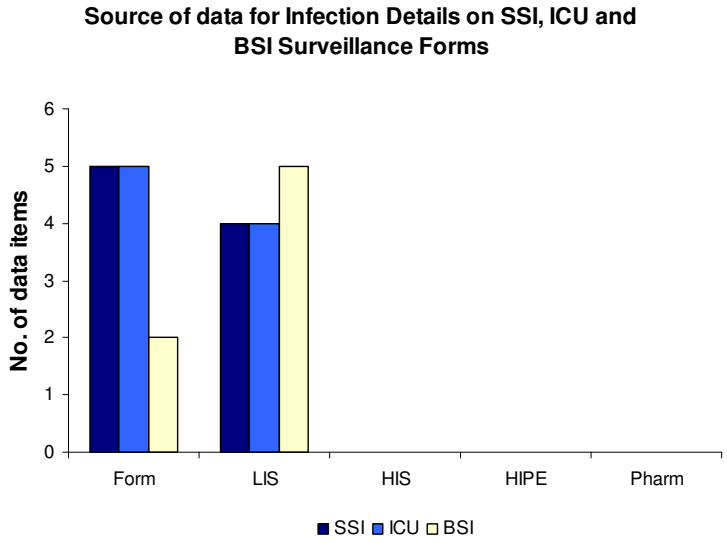


Figure 5.4 Sources from which individual data items relating to Infection detail may be collected in a hospital surveillance system

There are clear differences in the way data for these three categories of data item (i.e. Patient/Hospital Detail, Event Detail and Infection Detail) may be collected. For example, the majority of the patient/hospital details would generally be extracted from the hospitals patient information system. Most event details would have to be gathered using a specifically designed surveillance forms as they relate to clinical

diagnosis of the patient's status (e.g. is the patient immunocompromised?; what is the patients ASA score?) and can only be determined by medical or nursing staff working closely with the patient. Most of the infection details, like organism and resistance profile, would be available through the laboratory information management system, but a number of infection details, particularly those relating to a clinical interpretation of laboratory information, would need to be collected on a surveillance form.

This analysis emphasises that surveillance of infectious disease within the hospital is a multi-disciplinary effort and may require access to many hospital systems and co-operation from a wide range of staff members to obtain all the relevant information. However, the model proposed in Figure 5.1 lays a solid foundation for a scalable hospital surveillance system.

5.4. Discussion:

Hospital surveillance systems are an important aspect of service provision. Despite this, gathering detailed information on the design, implementation and standards for hospital based surveillance systems is a difficult task. In this Chapter, a reverse engineering approach was used to aid in the design of a hospital surveillance system.

The role of the Infection Prevention and Control Team

At the centre of the hospital system proposed in Figure 5.1, is the Infection Prevention and Control Team. Given that the hospital in question is a medium sized acute hospital setting (between 250 and 350 beds), this team is an appropriate fulcrum through which the surveillance system operates. Membership includes the consultant microbiologist, surveillance scientist, infection control nurses. It is proposed that a pharmacy representative be invited to join the core membership. In addition, it is proposed that a Senior Medical Scientist from the Microbiology Department and a practice development representative also be included in the group as needs arise. In other hospitals, there may be more appropriate teams apart from the infection control team that may act as the focus for surveillance. In addition, it may be appropriate for other professionals to participate (e.g. ID Consultants, Epidemiologists, Surveillance Nurses, Statisticians).

Surveillance activities not included in routine surveillance

The model for a hospital surveillance system presented in Figure 5.1 encompasses the majority of surveillance activities in the hospital setting. However, three notable scenarios are not covered by this model for various reasons: Outbreak surveillance, infectious disease notifications to public health and ad-hoc requests for surveillance data. These types of surveillance are not appropriate for monthly or even weekly reporting cycles as timely action is needed in most cases. A brief discussion of how these surveillance activities should be conducted follows:

Outbreak Surveillance

Outbreak surveillance is an important activity in the hospital setting. Outbreaks cannot be predicted and may occur at any time. Outbreak surveillance should therefore be considered a separate activity from routine infectious disease surveillance.

A model for outbreak control and management is in place in the hospital in question and it is envisaged that this structure will continue to operate outside of routine surveillance activities. A brief description of the key aspects of the outbreak management structure includes:

- Once an outbreak has been detected within the hospital, an outbreak committee is convened to manage the situation on a daily basis. The membership of this committee usually contains all members of the infection control team as well as representatives from management, nursing and clinicians.
- In terms of the data collection and reporting aspects of outbreak surveillance, a balance must be maintained between gathering useful and relevant information and timeliness. When the outbreak is first identified, a minimum surveillance data set is agreed and collection of data begins immediately.
- The surveillance team updates the outbreak committee on a daily basis to present analyses of data and discusses recent trends.
- Finally, once the outbreak is over, an outbreak report is issued and education sessions are held in order to feed back to all staff the lessons learned from the outbreak.

Notification of infectious disease to public health

A pathway is in place nationally for notification to public health of incidence of infectious disease. Both clinicians and laboratories are required to notify public health of all cases of notifiable diseases, a full list of which is presented in Appendix 1. It is important that this notification be completed in a timely manner in order that public health professionals can put in place appropriate control measures and prevent the spread of infection.

Notifications by clinicians are made on a form designed to capture all the information necessary for public health to take appropriate action where necessary. In the majority of cases, laboratories notify public health of notifiable diseases through the Computerised Infectious Disease Reporting system. This information system has been developed in Ireland and allows laboratories to upload information from LIS, or to manually input data on the system. For a minority of diseases, paper laboratory notifications are made to public health as the CIDR system has not been fully rolled

out to include some diseases such as tuberculosis and sexually transmitted infections (STIs).

Ad-Hoc requests for surveillance data

It is important to have a system in place so that users can request specific surveillance information that is not covered in routine reporting structures. Such requests can stem from changes in clinical practice or FOI enquiries for example. A policy is in place in the hospital where all requests of this nature go through the infection prevention and control team. Typically, the surveillance scientist extracts information from the relevant systems. These data are then collated and a report produced. Before replies are sent to those requesting information, reports are reviewed and signed off by an appropriate person, typically the Consultant Microbiologist. The elimination of committee structures from this pathway ensures that the turnaround time for generating the appropriate information is minimised.

Validation of hospital surveillance data

In terms of validation of surveillance data, there is a significant opportunity in a hospital setting to compare surveillance data to data contained in other systems. For example, a risk form is submitted for every HAI identified in the hospital setting and this information is then entered into the STARSWEB database system. As a result, the numbers of HAI identified in infectious disease surveillance should correspond to the numbers of HAI recorded in STARSWEB. It is proposed that a validation exercise between Quality and Risk department and the Surveillance system be conducted routinely on a quarterly basis. In addition, prevalence surveys of HAI are conducted periodically and these can also be used to validate surveillance system data. These types of surveys are infrequent, however, so validations can only be conducted as the opportunity arises.

HIPE coded data contains a range of clinically coded data relating to infectious disease. While HIPE coding is somewhat reliant on the same data sources as the surveillance system, the possibility exists to compare incidence of a number of infectious disease from both the HIPE and surveillance systems. It should be highlighted, however, that these figures need to be analysed appropriately as some clinically coded cases of infectious disease are coded on the basis of clinical diagnosis only (i.e. no laboratory confirmation). Furthermore, HIPE data is not timely by

definition, as there are a lot of resources needed to accurately code all hospital data. Nevertheless, it may be appropriate to perform quarterly validations for a number of key data items between the surveillance system and HIPE.

5.5 Conclusion

Chapter 5 is an important part of this thesis as it demonstrates how the information gathered in Chapters 3 and 4 in particular can be used to improve surveillance structures in the hospital setting. This Chapter was by no means exhaustive, however, due to the limitations of the amount of work that can feasibly be included in a Masters thesis of these proportions.

Chapter 6

Concluding remarks

Infectious disease surveillance in the hospital setting in Ireland is an ever evolving landscape. Currently, three surveillance datasets are collected at a national level through the health protection surveillance centre, namely EARSS data, ICU MRSA surveillance data and antimicrobial consumption data. In the coming years, it is likely that the volume of hospital surveillance data collected at a national level will increase. Add to this the reality that there will always be a need for a wide range of local surveillance datasets and it is clear that a lot of consideration and discussion is needed to ensure that each hospital has a robust and effective surveillance system in place.

Chapters 4 and 5 of this thesis described the needs of users and stakeholders in a specific hospital setting in Ireland, and proposed a structure for a surveillance system that would meet the needs of all users in this setting. It is important to recognise, however, that the general principles discussed and the methodology used could be adapted to other hospital settings in Ireland. For example, the template for the needs assessment could easily be modified and used in other settings. It is recommended that for future use, Part 4 of the interview (relating to users experience of other hospital surveillance systems) be omitted as it did not reveal much useful information.

In addition, Chapter 3 presented a review of national nosocomial surveillance systems employed in other jurisdictions. This information may be useful not only at a local hospital level but also at a national level as it is envisaged in the coming years that these types of surveillance will be implemented nationally. However, it is now that surveillance systems are being developed at a hospital level. It is therefore important for hospitals to be aware of the implications of these types of surveillance in terms of resources needed and how data collection can be streamlined to fit in with other surveillance activities already in place.

Resources for Surveillance

This thesis has investigated and discussed a number of aspects of hospital surveillance. It is clear from this study, that surveillance is a complex discipline and brings together a wide range of professional groups within the hospital setting. However, surveillance systems need to be adequately resourced. For example, a

significant amount of surveillance data is routinely stored in Laboratory Information Systems in hospitals, but in order to access this information, personnel (e.g. Surveillance Scientist) need to be in place with the skill set to extract, collate and analyse data and produce useful reports. In addition, personnel involved in maintaining a hospital surveillance system need support from a range of hospital groups including management (for financial support for surveillance initiatives), ICT and administration.

The Future for Surveillance

The technologies described in this thesis in relation to hospital surveillance are varied and include database systems (e.g. HIS, LIS), decision support systems (e.g. automated laboratory instrumentation software), optical character recognition software (e.g. for scanned images of surveillance forms), system interfaces (e.g. between HIS and LIS) and statistical analysis software packages (e.g. for analysing surveillance data). While it is clear that technology plays an important role in surveillance in the current climate, it is likely that in the future, technology will play an even bigger role. In an age where the electronic healthcare record is standard rather than an aspirational goal for many hospitals in Ireland, the possibility exists that all surveillance data may be stored in a single computerised system. While this may greatly simplify the process of data collection, it will remain an important foundation of any surveillance system that appropriate datasets are collected with clear definitions and standards in place. In addition, more complex statistical methods may be developed to analyse surveillance data in the future. For example, new statistical algorithms in bioinformatics may be necessary to analyse laboratory data in the genomics age. In the area of feedback to users and stakeholders, developments in communications technology may greatly simplify access to data but it will remain a fundamental goal of surveillance systems that appropriate interpretations of information are communicated effectively to those who need to know.

In summary, surveillance is an ever changing discipline and this thesis is intended to provide a framework to develop an effective surveillance system that will meet the needs of users not only today, but will be flexible enough to accommodate new types of surveillance as the need arises. After all, micro-organisms continue to evolve and surveillance methods must keep pace in order to meet the challenges of the future.

Bibliography

Barwolff, S. Sohr, D., Geffers, C., Brandt, C., Vonberg, R.P., Halle, H., Ruden, H. And Gastmeier, P. (2006) Reduction of Surgical Site Infections after Caesarean delivery using surveillance. J. Hosp. Infect. 64(2): 156-161

Brandt, C., Sohr, D., Behnke, M., Daschner, F., Rudn, H. And Gastmeier, P. (2006) Reduction of surgical site infection rates associated with active surveillance. Infect Contol Hosp Epidemiol, 27(12): 1347-1351.

CDC (2006) Principles of Epidemiology in Public Health Practice, Third Edition. Available for download from CDC Website (http://www.cdc.gov/)

CDC NNIS System. (2004). National Nosocomial Infections Surveillance (NNIS) System Report, data summery from January 1992 through June 2004, issued October 2004. *American Journal of Infection Control* **32,** 470-485.

CDC NNIS, 2007: NNIS Homepage Available at: http://www.cdc.gov/ncidod/dhqp/nnis.html

Coello, R., Charlett, A., Wilson, J., Ward, V., Pearson, A. and Borriello, P. (2005) Adverse impact of surgical site infections in English hospitals. J. Hosp. Infect. 60(2): 93-103.

Colyer, C. (2003). Childbed Fever, a 19th Century Mystery. Available at: http://www.sciencecases.org/childbed_fever/childbed_fever.asp. .

Declich, S., and Carter, A. O. (1994). Public health surveillance: historical origins, methods and evaluation. *Bulletin of the World Health Organisation* **72,** 285-304.

EARSS (2007) EARSS Homepage Available at: http://www.rivm.nl/earss/

Edmond, M.B., Wenzel, R. P. and Pasculle, W.A. Vancomycin-Resistant *Staphylococcus aureus*: Perspectives on Measures Needed for Control (1996) Ann. Intern. Med. 124(3): 329-334

Emori, TG et al. (1991) National nosocomial infections surveillance system (NNIS): description of surveillance methods. Am J Infect Control. 1991 Feb;19(1):19-35.

Emori T.G. and Gaynes R.P. (1993) An overview of nosocomial infections, including the role of the microbiology laboratory. Clin Microbiol Rev. 6(4):428-42.

Garner JS, Jarvis WR, Emori TG, Horan TC and Hughes JM. CDC definitions for nosocomial infections. In: Olmsted RN, ed.: APIC Infection Control and Applied Epidemiology: Principles and Practice. St. Louis: Mosby; 1996: pp. A-1--A-20.

Gastmeier, P., Sohr, D., Brandt, C., Eckmanns, T., Behnke, M. And Ruden, H. (2005) Reduction of orthopaedic wound infections in 21 hospitals. Arch Orthop Trauma Surg., 125(8): 526-530.

Gastmeier, P., Geffers, C., Brandt, C., Zuschneid, I., Sohr, D., Schwab, F., Behnke, M., Daschner, F. And Ruden, H. (2006) Effectiveness of a nationwde nosocomial infection surveillance system for reducing nosocomial infections. J. Hosp Infect., 64(1): 16-22.

Gaynes, R., Richards, C., Edwards, J., Emori, T. G., Horan, T., Alonso-Echanove, J., Fridkin, S., Lawton, R., Peavy, G., Tolson, J., and NNIS. (2001). Feeding Back Surveillance Data To Prevent Hospital-Acquired Infections. *Emerging Infectious Diseases* **7,** 295-298.

Geubbels, E.L., Nagelkerke, N.J., Mintjes-De Groot, A.J., Vandenbroucke-Grauls, C.M., Grobbee, D.E. and De Boer, A.S. (2006) Reduced risk of surgical site

infections through surveillance in a network. Int. J. Qual. Health Care, 18(2): 127-33.
Health Protection Agency. (2004). Protocol for Surveillance of Surgical Site Infection (Version 3.4). London: Health Protection Agency, 2004. .
Health Protection Agency. (2006). Surveillance of Surgical Site Infection in England (October 1997 - September 2005). London: Health Protection Agency, July 2006. .
HELICS, (2007): HELICES Homepage. Available at: http://helics.univ-lyon1.fr/helicshome.htm
HELICS. (2004a). Prevalence Surveys of Noscomial Infections Protocol Version 7.0 Final (May 2004). EU: EC DG SANCO F/4. .
HELICS. (2004b). Surveillance of Surgical Site Infections Protocol Version 9.1 (September 2004). EU: EC DG SANCO F/4. .
HPA. (2005). Results of the first year of mandatory Clostridium difficile reporting: January to December 2004. *CDR Weekly* **15,** 1-3.
HIPE (2007) HIPE Website. Available at: http://www.esri.ie/health_information/hipe/
Kahn, R. L. & Cannell, C. F. 1957 – The dynamics of interviewing. Theory, techniques and cases, Wiley (New York)
Mangram, A. J., Horan, T. C., Pearson, M. D., Silver, L. C., and Jarvis, W. R. (1999). Guideline for Prevention of Surgical Site Infection, 1999. *Infection Control and Hospital Epidemiology* **20,** 247- 278.
McConkey, S.J., L'Ecuyer, P.B., Murphy, D.M., Leet, T.L., Sundt, T.M. and Fraser, V.J. (1999) Results of a comprehensive infection control program for reducing surgical site infections in coronary artery bypass surgery. Infect. Control Hosp. Epidemiol., 20(8): 533-538.
McLaws, M. L., and Taylor, P. C. (2003). The Hospital Infection Standardised Surveillance (HISS) programme: analysis of a two-year pilot. *Journal of Hospital Infection* **53,** 259-267.
NCCLS. (2002). Analysis and Presentation of Cumulative Antimicrobial Susceptibility Test Data; Approved Guideline. NCCLS document M39-A [ISBN 1-56238-463-5]. NCCLS, 940 West Valley Road, Suite 1400, Wayne, Pennsylvanian 19087-1898 USA, 2002. .
NCCLS. (2003). Standard Guide for Functional Requirements of Clinical Laboratory Information Management Systems. NCCLS document LIS8-A [ISBN 1-56238-496-1]. NCCLS, 940 West Valley Road, Suite 1400, Wayne, Pennsylvanian 19087-1898 USA, 2003. .
NDSC. (2003a). Recommendations for Antibiotic Stewardship in Irish Hospitals. Interim Report by the Hospital Antibiotic Stewardship Working Group (SARI). Dublin: National Disease Surveillance Centre, 2003. .
NDSC. (2003b). Recommendations on Surveillance of Antibiotic Consumption in Ireland. Interim Report by the Antibiotic Consumption Surveillance Working Group (SARI). Dublin: National Disease Surveillance Centre, 2003.
Noakes TD, Borresen J, Hew-Butler T, Lambert MI and Jordaan E. (2007) Semmelweis and the aetiology of puerperal sepsis 160 years on: an historical review. Epidemiol Infect., 1-9 [Epub ahead of print]
Pittet, D (2005) Considerations for a WHO-European Strategy on healthcare associated infection, surveillance and control. Lancet Infect Dis Vol 5, pg 242-50.

Platt, R., Yokoe, D. S., Sands, K. E., and Investigators, C. E. M. P. E. (2001). Automated methods for Surveillance of Surgical Site Infections. *Emerging Infectious Diseases* **7,** 212-216.

Rello J, Ollendorf DA, Oster G, Vera-Llonch M, Bellm L, Redman R, Kollef MH; VAP Outcomes Scientific Advisory Group. Epidemiology and outcomes of ventilator-associated pneumonia in a large US database. Chest, 122(6):2115-2121

Samore, M., Lichtenberg, D., Saubermann, L., Kawachi, C., and Carmeli, Y. (1997). A clinical data repository enhances hospital infection control. *Proc AMIA Annu Fall Symp* **,** 56-60.

Shorr, A.F. (2007) Epidemiology and Economic Impact of Meticillin-Resistant Staphylococcus aureus: Review and Analysis of the Literature. Pharmacoeconomics.25(9):751-68.

Schneeberger, P.M., Smits, M.H., Zick, R.E. and Wille, J.C. (2002) Surveillance as a starting point to reduce surgical-site infection rates in elective orthopaedic surgery. J. Hosp. Infect. 51(3): 179-184.

Suljagić V, Cobeljić M, Janković S, Mirović V, Marković-Denić L, Romić P, Mikić D. Nosocomial bloodstream infections in ICU and non-ICU patients. Am J Infect Control, 33(6):333-40.

VICNISS, 2007: VICNISS Homepage. Available at: http://www.vicniss.org.au/

Wenzel, R. P. (2007) Health care-associated infections: major issues in the early years of the 21st century. *Clin Infect Dis*., 45(1):S85-8

Wenzel, R.P. and Edmond, M.B. (2001) The impact of Hospital-Acquired Bloodstream Infections. Emerging Infectious Diseases, 7(2): 174-177.

WHO. (2002). Prevention of Hospital-Acquired Infections: A Practical Guide, 2nd Edition. WHO Dept. of Communicable Disease, Surveillance & Response, 2002.

WHO (2001) Surveillance Standards for Anti-microbial Resistance. WHO Department of Communicable Disease, Surveillance and Response, 2001.

Wilson JA, Ward VP, Coello R, Charlett A and Pearson A. (2002) A user evaluation of the Nosocomial Infection National Surveillance System: surgical site infection module. J Hosp Infect, 52(2):114-21.

Zuschneid, I., Schwab, F., Geffers, C., Ruden, H. and Gastmeier, P. (2003) Reducing central venous catheter-associated primary bloodstream infection in intensive care units is possible: data from the German nosocomial infection surveillance system. Infect Control Hosp Epidemiol., 24(7): 501-505

Appendix 1: List of current Notifiable diseases (as per legislation SI 707 of 2003)

Acute anterior poliomyelitis (Polio virus)
Acute infectious gastroenteritis
Ano-genital warts
Anthrax (Bacillus anthracis)
Bacillus cereus food-borne infection/intoxication
Bacterial meningitis (not otherwise specified)
Botulism (Clostridium botulinum)
Brucellosis (Brucella sp.)
Campylobacter infection (Campylobacter sp.)
Chancroid (Haemophilus ducreyi)
Chlamydia trachomatis infection (genital)
Cholera (Vibrio cholerae)
Clostridium perfringens (type A) food-borne disease
Creutzfeldt Jakob disease
nv Creutzfeldt Jakob disease
Cryptosporidiosis (Cryptosporidium parvum)
Diphtheria (Corynebacterium diphtheriae)
Echinococcosis (Echinococcus sp.)
Enterococcal bacteraemia
Enterohaemorrhagic Escherichia coli
Escherichia coli infection (invasive)
Giardiasis (Giardia lamblia)
Gonorrhoea (Neisseria gonorrhoeae)
Granuloma inguinale
Haemophilus influenzae disease (invasive)
Hepatitis A (acute) (Hepatitis A virus)
Hepatitis B (acute and chronic) (Hepatitis B virus)
Hepatitis C (Hepatitis C virus)
Herpes simplex (genital) (Herpes simplex virus)
Influenza (Influenza A and B virus)
Legionellosis (Legionella sp.)
Leptospirosis (Leptospira sp.)
Listeriosis (Listeria monocytogenes)
Lymphogranuloma venereum
Malaria
Measles (Measles virus)
Meningococcal disease (N. meningitidis)
Mumps (Mumps virus)
Non-specific urethritis
Noroviral infection (Norovirus)
Paratyphoid (Salmonella paratyphi)
Pertussis (Bordetella pertussis)
Plague (Yersinia pestis)
Q Fever (Coxiella burnetii)
Rabies (Rabies virus)
Rubella (Rubella virus)
Salmonellosis (Salmonella enterica)
Severe Acute Respiratory Syndrome
Shigellosis (Shigella sp.)
Smallpox (Variola virus)
Staphylococcal food poisoning
Staphylococcus aureus bacteraemia
Streptococcus group A infection (invasive)
Streptococcus pneumoniae infection (invasive)
Syphilis (Treponema pallidum)
Tetanus (Clostridium tetani)
Toxoplasmosis (Toxoplasma gondii)
Trichinosis (Trichinella sp.)
Trichomoniasis (Trichomonas vaginalis)
Tuberculosis (M. tuberculosis complex)
Tularemia (Francisella tularensis)
Typhoid (Salmonella typhi)
Typhus (Rickettsia prowazekii)
Viral encephalitis
Viral meningitis
Viral haemorrhagic fevers
Yellow Fever (Yellow Fever virus)
Yersiniosis

Appendix 2: Surveillance Forms from National Nosocomial Surveillance Systems

List of Forms included:

1. NNIS SSI Surveillance form
2. VICNISS SSI Surveillance form
3. HELICS SSI Surveillance form
4. NNIS ICU Surveillance form
5. VICNISS ICU Surveillance form
6. HELICS ICU Surveillance form
7. NNIS BSI Surveillance form
8. VICNISS BSI Surveillance form
9. EARSS Surveillance form
10. Enhanced EARSS Surveillance form
11. Prevalence Survey of Healthcare Associate Infection 2006 form
12. HELICS Nosocomial Prevalence Survey form

Appendix 3: Semi Structured Interview Template

Needs Assessment of Surveillance System Users & Stakeholders
Semi-Structured Interview Template

Date: **Time:** **Location:**

Interviewee:

Interviewer: Dr Michael Carton, Surveillance Scientist

Research Question: To explore issues relating to the needs of the hospital surveillance system users & stakeholders

Introduction: This interview is being conducted in as part of a needs assessment being carried out in relation to surveillance activities at a hospital level. All data will be anonymised and the results of these interviews will be fed back by the infection control team to the Hospital Infection Control Committee. With the agreement of the participant, the results will also form part of an MSc Thesis in Health Informatics (TCD) being submitted by the interviewer (in which all data will be anonymised).

The interview includes questions on 6 topics of relevance to Surveillance in the hospital setting. Interviewees are invited to give feedback on the issues raised as well as any other relevant issues they would like to include. This interview is intended to capture the needs and views of users/stakeholders in hospital surveillance.

Part 1. Identifiying the stakeholders/users of the surveillance system.

(a) Profession/current position of interviewee?

(b) Do you see yourself as a surveillance system user or stakeholder?

(c) Who (or what professional groups) would you consider are other stakeholders/users of the hospital surveillance system?

- ☐ Consultant Microbiologists
- ☐ Clinicians
- ☐ GPs
- ☐ Medical Scientists/Surveillance Scientists/Laboratory Staff
- ☐ Infection Control Nurses
- ☐ Pharmacy staff
- ☐ Nurses and Nurse managers
- ☐ Hospital Management
- ☐ Patients

Any other not listed:

Part 2. **Identifying the information needs of stakeholders/users of the surveillance system.**

(a) What types of Surveillance data would you like to receive? (please include as much detail as possible)

(b) How you like these data broken down? e.g. by ward/cohort/speciality/clinician?

(c) Would you like a context included? For example, where possible, would you like to have regional or national data (or a relevant standard) included for comparison?

(d) Bearing in mind that a balance is needed between what is relevant and what is interesting, are there other data types you think may not be directly related to your own job/profession but that you would be interested in receiving anyway?

(e) In your current job/position, are the data sets you have outlined available to you?

Part 3. **Identifying the medium through which to deliver surveillance information.**

(a) In what way would you most like to receive your Surveillance Data?

- ☐ Hard Copy printed (by post)
- ☐ By E-mail
- ☐ Website
- ☐ Notice board
- ☐ In person
- ☐ Through committee meetings

(b) How often would you like to have these data fed back to you?

- ☐ Routinely:
- ☐ On request

(c) Are there any formats/media that you think are not appropriate for presenting surveillance data (or that would discourage you from reading surveillance reports)?

Part 4. Identifying previous experience with surveillance systems.

(a) In relation to your background, have you worked in other jobs or other facilities where surveillance data was available to you?

If No, please skip to Topic 5.

Part 5. **Identifying opinions of interviewees on how the surveillance system should operate.**

(a) **Pharmacy data** has not already been discussed:
Would you be interested in receiving antimicrobial usage/consumption data?

(b) If the role of **Hospital Management** in surveillance was not already discussed**:**
What type of surveillance data do you think it is important or appropriate for Hospital Management to receive?

(c) If the role of **Patients** in surveillance was not already discussed**:**
Where do you see the role of patients in terms of access to surveillance data?

> Some debate has taken place on this topic and there is a view that the role of patients needs a national lead (e.g. from NHO) because, if individual hospitals take the lead, they will receive adverse media attention. Do you agree with this view?

(d) In your current job/position, what do you think is the single most important Surveillance issue that you would like to see addressed in the short term?

(e) Are there any committees either locally or regionally that you participate in that you would like to see surveillance data presented at or forwarded to?

- □ Hospital Infection Control Committee
- □ Regional Infectious Disease Committee
- □ Regional Zoonosis Committee
- □ Regional Infection Control Committee
- □ Hospital Drugs and Therapeutics Committee
- □ Regional SARI committee
- □ Hospital Quality and Risk Committee

Part 6. Communication between users and the surveillance system.

(a) When you are receiving information from the Surveillance System, what type of forum would you like to use to provide feedback to the surveillance team?

□ Contact details (e-mail and phone) at the end of reports
□ Through a Committee
□ In person to a member of the infection control team
□ Other:

Appendix 4: Comparison of LIS data formats with CLSI Guidelines

Data Type	Data Item	CLSI recommendation	Stored on LIS
Demographic	Unique patient idenitifier	Required	Yes
	Healthcare facility	Required	Yes
	Age/DoB	Desirable	Yes
	Sex	Desirable	Yes
	Nursing Unit	Desirable	Yes
	Clinical Service	Desirable	Yes
	Admission date	Desirable	Yes
	Clinical Details	Desirable	Yes
	Diagnosis	Desirable	No
	Current AB Therapy	Desirable	Yes
	Previous AB therapy	Desirable	No*
Specimen	Specimen number	Required	Yes
	Specimen type	Required	Yes
	Date of specimen collection	Required	Yes
	Body site from which specimen was obtained	Desirable	Yes
Organism	Genus and species	Required	Yes
	Accommodate changes in taxonomic nomenclature	Desirable	Yes
	Colonisation / infection	Desirable	No
	Community Acquired / nosocomial	Desirable	No
Susceptability	Quantitative test results and qualitative test interpretations for all Abs tested	Required	Yes
	Separate data fields for MIC value and interpretation	Required	Yes
	Susceptibility test method employed	Required	Yes
	Specialised test results if they represent primary test method (beta lactamase)	Required	Yes
	Specific test system used	Desirable	No
	Original result should be stored if expert results are invoked	Desirable	Yes

* No specific field for storing previous antibiotic therapy however, this information is sometimes provided by users in the Clinical Details field

Appendix 5: Analysis of Surveillance Datasets by Data Source

Surgical Site Infection Surveillance Dataset

Category^	Data Item	Format	Source
P/H Detail	Hospital Code	Numeric	Form
P/H Detail	Patient ID	Alpha Numeric	Form
P/H Detail	Patient Name	Alpha	HIS
P/H Detail	MRN	Numeric	HIS
P/H Detail	Sex	Male/Female	HIS
P/H Detail	DOB/Age	Date	HIS
P/H Detail	Date Admitted to Hospital	Date	HIS
P/H Detail	Date Discharged from Hospital	Date	HIS
E Detail	Procedure Date	Date	Form
E Detail	Event Date	Date	Form
E Detail	Date Last Follow up Post Discharge	Date	Form
E Detail	Surgeon Code	Alpha Numeric	Form
E Detail	Procedure Code	Alpha Numeric	Form
E Detail	ICD 9/10 Procedure Code	Alpha Numeric	HIPE
E Detail	Location	Free Text	Form
E Detail	Duration of Procedure	hrs mins	Form
E Detail	ASA Score	1-5 # or unavailable	Form
E Detail	Wound Class	1-4 $	Form
E Detail	Implant	Yes No	Form
E Detail	Multiple Procedures	Yes No	Form
E Detail	General Anesthesia	Yes No	Form
E Detail	Endoscopic Approach	Yes No	Form
E Detail	Trauma	Yes No	Form
E Detail	Emergency/Elective	Yes No	Form
E Detail	Prophylatic Antibiotic given	Yes No	Form
E Detail	Antibiotic Name	Free Text	Pharmacy
E Detail	Time Given	Prior to incision, after incision, etc	Pharmacy
E Detail	Antibiotic Continued for >24hrs	Yes No	Pharmacy
I Detail	Infection Detected	Yes No	Form
I Detail	Infection Date	date	Form
I Detail	When Detected	Admission/Post Discharge/Readmission	Form
I Detail	Infection Type	Superficial or Deep Incision/Organ Space	Form
I Detail	Laboratory Test	Culture/Visualisation/Other	LIS
I Detail	Specimen Type	Blood/CSF/Other	LIS
I Detail	Organism Isolated	Free Text	LIS
I Detail	Resistance Profile	Sensitive, Resistant, Intermediate	LIS
E Detail	Comments	Free Text	Form
I Detail	Secondary BSI	Yes No	Form
P/H Detail	Died	Yes No	HIS
E Detail	SSI Contributed to death	Yes No	Form

ICU Infection Surveillance Dataset

Category^	Data Item	Format	Source
P/H Detail	Hospital Code	Numeric	Form
P/H Detail	Patient ID	Alpha Numeric	Form
P/H Detail	Patient Name	Alpha	HIS
P/H Detail	MRN	Numeric	HIS
P/H Detail	Sex	Male/Female	HIS
P/H Detail	DOB/Age	Date	HIS
E Detail	Origin of Patient	This hospital/Long Term Care/Community	Form
P/H Detail	Date Admitted to Hospital	Date	HIS
E Detail	Type of Admission	Medical/Surgical	HIS
E Detail	Trauma	Yes/No	Form
E Detail	Impaired Immunity	Yes/No	Form
E Detail	Antimicrobial Treatment (at admission)	Yes/No	Pharmacy
P/H Detail	Date Admitted to ICU	Date	HIS
P/H Detail	Date Discharged from ICU	Date	HIS
P/H Detail	ICU Type/Code	List	Form
E Detail	Birthweight in grams (Neonates)	Numeric	Form
E Detail	Vaginal Delivery	Yes/No	Form
E Detail	Died	Yes/No	HIS
E Detail	Date of Death	Date	HIS
E Detail	Comments	Free text	Form
E Detail	Operation	Yes/No	Form
E Detail	Risk Factor - Central Line	Yes/No & Dates	Form
E Detail	Risk Factor – TPN	Yes/No & Dates	Form
E Detail	Risk Factor – Intubation	Dates	Form
E Detail	Risk Factor - Naso/Oro intestinal tube	Dates	Form
E Detail	Risk Factor – Ventilator	Yes/No & Dates	Form
E Detail	Risk Factor - Urinary Catheter	Yes/No & Dates	Form
E Detail	Risk Factor - Bladder instrumentation	Yes/No	Form
E Detail	Risk Factor – SSI	Yes/No	Form
E Detail	Risk Factor - Peripheral Line	Yes/No	Form
E Detail	Risk Factor - Umbilical Catheter	Yes/No	Form
E Detail	Risk Factor - Invasive Device/Procedure	Yes/No	Form
E Detail	Risk Factor - Acute Coronary Care	Yes/No	Form
E Detail	Risk Factor - Glasgow Coma Scale	Numeric	Form
E Detail	Antimicrobials Used in ICU	Name/Date/Prophylaxis, Empiric, AMR	Pharmacy
I Detail	Infection ID	Numeric	Form
I Detail	Major Infection Site	Pneumonia/BSI	Form
I Detail	Specific Infection Site	Free text	Form
I Detail	Infection Date	Date	Form
I Detail	Secondary BSI	Yes/No	Form
E Detail	Origin of BSI	Free text	Form
E Detail	Maternally acquired	Yes/No	Form
E Detail	Relationship to Death	Directly Related etc	Form
I Detail	Laboratory Diagnosis	Culture/Ag-Ab test/Visulation/Other	LIS
I Detail	Specimen Type	Free text	LIS
I Detail	Organism Name	Free text	LIS
I Detail	AMR Profile	Sensitive/Resistant/Intermediate	LIS

Bloodstream Infection Surveillance Dataset

Category^	Data Item	Format	Source
P/H Detail	Hospital Code	Numeric	Form
P/H Detail	Hospital Department	List	Form
P/H Detail	Laboratory Code	Alpha Numeric	LIS
P/H Detail	Current Date	Date	Form
P/H Detail	Patient ID	Numeric	HIS
P/H Detail	Patient Name	Alpha	HIS
P/H Detail	MRN	Numeric	HIS
P/H Detail	Sex	Male/Female	HIS
P/H Detail	DOB	Date	HIS
P/H Detail	Admission Date	Date	HIS
P/H Detail	Discharge Date	Date	HIS
E Detail	Origin of Patient	Admitted/Outpatient/Unknown	Form
E Detail	Died	Yes/No	HIS
E Detail	Comments	Free Text	Form
E Detail	BSI Contributed to Death	Yes/No	Form
E Detail	Clinical Diagnosis	Free Text	Form
E Detail	Date of Event	Date	Form
E Detail	Specific Event	Lab Confirmed/Clinical Sepsis	Form
E Detail	Post Procedure BSI	Yes/No	Form
E Detail	Date of Procedure	Date	Form
E Detail	Procedure Code	Numeric	Form
E Detail	ICD 9/10 Procedure Code	Numeric	HIPE
E Detail	Risk Factors – SC* - Temporary Central Line	Yes/No	Form
E Detail	Risk Factors - NICU - Umbilical Catheter	Yes/No	Form
E Detail	Risk Factors - NICU - Birth weight (g)	Numeric	Form
E Detail	Central Line insitu	Yes/No	Form
E Detail	Peripheral Line insitu	Yes/No	Form
E Detail	Detected >48hrs after admission	Yes/No	Form
I Detail	Organism Name	Free Text/List	LIS
I Detail	When Detected	During Admission/Post Discharge/Readmission	Form
I Detail	Specimen Collection Date	Date	LIS
I Detail	Isolate Sample No	Numeric	LIS
I Detail	Major Infection Site	Free Text/List	Form
I Detail	AMR Profile	Sensitive, Resistant, Intermediate	LIS
I Detail	MIC Results	Numeric	LIS