IMPLEMENTING CHANGE IN INFECTION CONTROL PRACTICE: AN ACTION RESEARCH STUDY IN TWO INTENSIVE CARE UNITS

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Contents

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Summary

The increased emergence of bacterial resistance to antibiotics means that primary prevention of all hospital-acquired infections is essential, but ensuring that infection control practice is evidence-based requires reliable measurement of endemic hospital-acquired infections. The research sought to develop a comprehensive method for combining surveillance of infection with improved infection control by incorporating a problem solving approach within nursing process documentation. Prior to the research there was little evidence of nursing documentation of infection risk assessment, evaluation or outcomes monitoring. Development of the documentation matched the aspirations for a clear, objective complete system to support infection control care planning and audit. The documentation was designed to collect and collate only routine items of clinical information that the nurse at the bedside on an ICU would already know or be able to access in a very short time. The data items were successfully incorporated within the audit documentation for measuring incidence of each of the four site-specific infections. The system provided a framework for case-mix identification, case definitions, data collection and identification of indicators for measurement of ICU-acquired infection. It was shown to be feasible to incorporate the audit tool within routine documentation of clinical care. The method has potential application for surveillance of endemic hospital-acquired infections in a wide range of clinical specialities and could be adapted by others facing similar difficulties in determining priorities for monitoring and controlling endemic hospital-acquired infections within limited resources.

Abbreviations Used

BSI	Blood Stream Infection
CDC	Communicable Disease Centre (USA)
ENB	English National Board for Nursing, Midwifery and Health Visiting
EPIC	European Prevention of Infection in Intensive Care study
ET	Endo-tracheal
GI	Gastro-intestinal
GITU	General Intensive Therapy Unit
ICARE	Intensive Care Antibiotic Resistance Epidemiology
ICN	Infection Control Nurse
ICU	Intensive Care Unit
ISCP	Infection Surveillance and Control Programmes (CDC, USA)
IV	Intra-vascular
LRTI	Lower Respiratory Tract Infection
MRSA	Methicillin-resistant *Staphylococcus aureus*
NHS	National Health Service
NINSS	Nosocomial Infection Surveillance Scheme (Colindale, UK)
NISU	Nosocomial Infection Surveillance Unit (Colindale, UK)
NNIS	National Nosocomial Infection Surveillance (USA)
PAS	Patient (computerised hospital) Administration System
PHLS	Public Health Laboratory Service (Colindale, UK)
PICU	Paediatric Intensive care Unit
RCN	Royal College of Nursing
RTA	Road Traffic Accident
SD	Standard Deviation
SENIC	The Study of the Effectiveness of Nosocomial Infection Control (USA)
SWI	Surgical Wound Infection
TPN	Total Parenteral Nutrition
UK	United Kingdom
UKCC	United Kingdom Central Council for Nursing, Midwifery and Health Visiting
USA	United States of America
UTI	Urinary Tract Infection
VRE	Vancomycin-resistane enterococcus
WBC	White Blood Cell (Count)

Chapter One

Hospital-acquired Infection

1.1 Introduction

Evidence exists for the effective prevention of hospital-acquired infection, yet this evidence is not being applied in practice. This thesis challenges the status of hospital infection control in the United Kingdom (UK) and attempts to address the immediate problems posed for the National Health Service (NHS). The barriers to delivering effective hospital infection control are increasing: technology is expanding, risks to patients are greater and resources are constrained. Whilst acknowledging the difficulties and restrictions to delivering effective infection control, the researcher developed an incremental approach over nine years to test the application of theory, generally derived from outside the UK, within routine practice in this country. The research explored a novel, practical and cheaper way of applying evidence in practice by developing and evaluating a comprehensive, prospective method for audit of hospital-acquired infection in patients requiring intensive care. The research sought to stimulate and develop nursing practice of effective infection control. Particular emphasis is placed on the role of nurses at the bedside and the research tested the potential for nurses to adopt a central co-ordinating role for infection control within nursing care.

The delivery of healthcare within the context of a "New NHS" has placed greater emphasis on professional accountability. This thesis argues for involvement of all healthcare professionals in delivering evidence based infection control and the development of information and reporting systems that can monitor and evaluate the structure, processes and outcomes of hospital infection control. An essential national programme of research and development activity has been initiated within the UK, but progress is slow and recommendations have yet to make an impact on clinical practice. The thesis argues for information systems which will meet the immediate needs of clinicians and their patients and stimulate action focused on: reducing risks, improving structures and processes of care, reducing hospital-acquired infection and conserving resources. Healthcare professions are challenged to consider the research that demonstrates the infection control theory-practice gap, to set an agenda for change and begin to apply evidence within their practice to assure the delivery of effective infection control. Resistance to change in the NHS is inevitable, but there needs to be evidence of efficacy of current systems for delivery of infection control.

Chapter 1 introduces the problem of hospital infection control, highlights the importance of the problem in the context of current health policy in the UK. The impact of hospital-acquired infection is discussed with reference to adverse effects. The introduction identifies and justifies the research problem as one of high priority for the NHS in the UK. Chapter 2 describes the strategy and methods used to review the literature. A critical analysis of the research is presented. A brief synopsis of the evidence concludes chapter 2, proposing change in hospital infection control and priorities for action within the intensive care unit. Chapter 3 focuses on infection acquired by patients requiring intensive care and presents the problem within the context of the intensive care unit, intensive care nurses and nursing. The development and design of the research programme is presented in chapter 4 with justification for the development of the methods in relation to the problem. Chapter 5 describes the process of accessing the research sites and gives an overview of the research methods. Chapter 6 presents the results of the research. Chapter 7 discusses the results and recommendations are made in Chapter 8.

1.2 Defining the problem

Two recent Department of Health reports have recognised the immediate and long-term problems of an increasing emergence of antibiotic-resistant bacteria. Both reports have direct implications for the control of hospital infection control in the UK (House of Lords Science and Technology Committee 1998; Standing Medical Advisory Committee 1998). Each report made direct reference to the problems of hospital-acquired infection, highlighting current difficulties in its effective control. An accompanying parliamentary letter stressed the scale of concerns and recommended a concerted effort to prevent, delay and control bacterial resistance to antibiotics (Department of Health 1998a). Both reports emphasised that provision of effective hospital infection control has a central role to play in controlling the escalation of bacterial resistance to antibiotics,

> *"As resistance to antimicrobials increases, so does the importance of infection control. Preventing spread of organisms which are resistant and therefore hard to treat is desirable. Less obvious, but equally desirable, is the control of infection by organisms which are still susceptible, every infection not prevented requires treatment, and every treatment adds to the selective pressure towards resistance".*
>
> House of Lords Science and Technology Committee 1998

Recommendations included a national campaign to increase health professional and public understanding of the issues; the primary purpose being to reduce unnecessary

and inappropriate antimicrobial use (Standing Medical Advisory Committee 1998). The increase in bacterial resistance to antibiotics is of global importance. Levy (1992), an expert on antibiotic use and resistance, highlighted that in developing countries people are dying of previously treatable diseases that are no longer responsive to traditional antibiotics. Levy used the term *"The Antibiotic Paradox"* to describe how the discovery of antibiotics *"heralded medicine's triumph"* over previously fatal diseases but which has now led to the *"terrifying reality"* of antibiotic-resistant bacteria. In considering the problem of bacterial resistance to antibiotics, the House of Lords Science and Technology Committee and the Standing Medical Advisory Sub-Committee both received evidence from experts in the UK and the United States of America (USA). One expert professional group that gave evidence to the sub-committee of the Standing Medical Advisory Committee was the English National Board (ENB) for Nursing, Midwifery and Health Visiting. In a newsletter published in January 1999, the ENB drew attention to the evidence they had presented to the Standing Medical Advisory Committee by the ENB. This was that infection control was an *"important topic within all pre-registration nursing and midwifery education programmes"* (English National Board for Nursing, Midwifery and Health Visiting 1999). The ENB stressed that the theme of infection control continues throughout the whole programme of nurse preparation for practice.

> *"Periods of practical experience reinforce and develop the theoretical knowledge gained by students. The topic is included in a wide variety of Board approved post-registration programmes."*
>
> English National Board for Nursing, Midwifery and Health Visiting 1999

As the regulatory body responsible for standards in education, the ENB emphasised their expectation that the topic of antibiotic resistance is included in all pre-registration nurse education programmes; but the ENB have initiated action to reinforce these recommendations (English National Board for Nursing, Midwifery and Health Visiting 1999). However, many researchers have recognised that despite the availability of clear guidelines and a solid knowledge base, healthcare professionals often choose to ignore, or compromise, recommended infection control recommendations. Handwashing is regarded as the largest contributory factor for prevention of hospital-acquired infection, and its relationship to reducing hospital-acquired infection has been demonstrated (Casewell and Phillips 1977; Albert and Condie 1981; Conly *et al.* 1989; Civetta *et al.* 1990; Simmonds *et al.* 1990; Garland 1996). Handwashing techniques are inadequate throughout all health professional groups (Casewell and Phillips 1977; Taylor 1978a; Taylor 1978b; Elliot 1989; Sneddon 1990).

The House of Lords report (House of Lords Science and Technology Committee 1998) discussed funding applied research in control of infection. They believed that the conflicting demands of teaching, administration, clinical service and the UK Research Assessment Exercise were restricting research progress in this field. The report stressed that the required research programmes are failing to receive support from either major funding bodies or the NHS.

> *"In short, across the range of enquiry, there appear to be research needs, and a lack of public resources to meet them. The research in question would be highly applied, whether into better ways to use existing antibiotics, or ways to educate doctors and patients [...] or means to prevent and control infection, or systems of surveillance."*
>
> House of Lords Science and Technology Committee 1998

The issue of infection control as a topic for academic research has been debated. Burnie (1999), a UK Microbiologist, believed that the consequences of lack of infection control in terms of patient morbidity, mortality and costs justifies the importance of infection control as an academic subject. Griffiths-Jones (1999) referred to Burnie's paper and presents a nursing perspective to his concerns. She emphasised that knowledge of how invading micro-organisms interact with their human host is essential to contain and treat infection. Griffiths-Jones commented, *"without this fundamental knowledge, prevention and treatment regimens can become unreliable, unstructured and ineffective."* Whilst acknowledging that the NHS is well equipped with policies for infection control, many problems and issues were raised in the process of the House of Lords Science and Technology Committee receiving evidence. Problems identified that relate to hospital infection control within the UK were that:

- some infection control teams were understaffed and under-resourced
- there was evidence of poor standards of basic hygiene
- problems were exacerbated by the contracting-out of cleaning services
- there was evidence of inadequate facilities for isolation
- there was over-crowding of patients
- there was *"hot-bedding"* of patients with inadequate infection control
- there was inadequate control of agency staff and
- there was inadequate training of all staff (even in the basics of hygiene)

The House of Lords Science and Technology Committee report (1998) made extensive recommendations. Those with relevance to the control of hospital-acquired infection

were that specific guidelines need to be developed and these needed to be supported by professional education. Hospital-acquired infections increase patients' pain and suffering and prolong their lengths of stay. Hospital-acquired infection not only has a severe impact on the patient's experience of healthcare, in some cases causing death and it is very expensive (Department of Health 1995). Infections are still an important cause of mortality & morbidity and effort to prevent them should be second nature to all hospital staff (Department of Health 1995). The difficulty in teaching health professionals basic principles of good infection control practice, the lack of knowledge about infection control and problems due to poor compliance by health professionals in basic hygiene causes grave concern. Whilst striving for high quality care within limited resources is the norm for health services world-wide, there is also the issue of rising litigation in the NHS. Consumers have a heightened awareness of the major adverse incidents occurring within the NHS. The white paper for the *'NHS in England - Modern and Dependable'* (Department of Health 1997) and the consultative document, *'A First Class Service: Quality in the new NHS'* (Department of Health 1998b) proposed changes to support the *"delivery of more consistent and higher quality care to patients".* These changes will be provided within a framework of clinical governance, which seeks to, *"build a single, coherent, local programme for quality improvement"* (Department of Health 1998b) and help *"all clinicians to improve quality and safeguard standards of care continuously"* (Royal College of Nursing 1998). NHS Trusts will have a duty to ensure and demonstrate that they have delivered high quality care (Royal College of Nursing 1998). National standards for health services and treatments will be delivered through National Service Frameworks and a National Institute for Clinical Excellence. A Commission for Health Improvement, within an NHS Performance Assessment Framework (Department of Health 1998b), will monitor the processes.

Central to the government's aims to build a modern and dependable health service is to improve the use of information and information technology and make this a positive contribution to improving the way health services are provided (Department of Health 1998c). There is increasing interest in the effectiveness and efficiency of health care delivery, and evidence of good hospital infection control programmes can reduce the incidence of hospital-acquired infection (Department of Health 1995). To date, there are no comparative data about the effectiveness of infection control in the UK, (Department of Health 1995, Glynn *et al.* 1997). Individual clinicians, who may be aware of potential infection control problems in their specialty, have no reliable means to judge their own practice against standard rates or acceptable thresholds for hospital-acquired infection. Standard methodologies for surveillance of hospital-acquired infection

in the UK are published (Glenister *et al.* 1992; Spencer 1993; Glynn *et al.* 1997), but there are still no professionally agreed definitions for hospital-acquired infection (Crowe and Cooke 1998). Conducting a hospital-acquired incidence study is expensive, labour-intensive, requires specialist infection control expertise to interpret a large amount of microbiological and clinical information. Evidence from the USA, where during the 1970s hospital-wide surveillance was required for accreditation purposes, suggests that the large quantities of data collected there were not always used. Larson *et al.* (1988), in discussing hospital-acquired infection as a quality indicator, highlighted that in the USA recent trends have been towards targeted surveillance. A proportion of hospital-acquired infections are unavoidable due to patient and environmental risk factors, but there is evidence of effective hospital infection control programmes (Department of Health 1995) with reductions of hospital-acquired infections being reported from around 30%, (Haley *et al.* 1981;Haley *et al.* 1985; French *et al.* 1989), up to 49% (Raine, 1991). This evidence has been mainly derived from studies outside the UK, but has widespread acceptance amongst experts in the UK. Research has focused on introducing strategies directed at modifying clinical practice through improved infection control services (Haley *et al.* 1985; French *et al.* 1989). Cost-effective strategies for hospital infection control were identified in the SENIC study (Haley *et al.* 1985), yet the implementation of the SENIC evidence has not been tested within the NHS. Currently there are no methods to judge the potential impact that a SENIC-style approach would have on clinical and economic outcomes in the UK. Despite advances in medicine, technology, treatment techniques, control of infection methods and a scientific understanding of the aetiology and epidemiology of infection, control of hospital-acquired infection continues to cause concern. The potential cost to patients, health providers, the NHS and society as a whole have, to date, only been extrapolated from research conducted outside the United Kingdom (Currie and Maynard 1989, Plowman *et al.* 1997). The full extent of the impact of hospital-acquired infection on a patient's short and long term experiences is not measured in the UK. The problem of hospital infection is clearly expressed and its importance is recognised. All the evidence suggests that effective infection control would improve quality of care, reduce costs and prevent deaths in the NHS.

Chapter Two

The Literature Review

Reviews undertaken by the researcher from 1990 to 1996 provided the framework and key themes for the literature review for this thesis. The search used a variety of computerised resources including MEDLINE, HealthPLAN CD, CINAHL, Department of Health: Outcomes Clearing House and the King's Fund Centre Database. Searches used a variety of primary search terms for hospital-acquired infection (cross-infection, hospital infection, nosocomial infection, and iatrogenic infection) and intensive & critical care. Other primary searches were undertaken to identify important contributions to the evidence base. Terms used were: handwashing, practice development, knowledge and practice, education, job satisfaction, health economics, cost-benefit analysis, healthcare informatics, quality assurance, clinical audit, quality, risk management, outcome & process evaluation and action research. Literature on most themes was extensive and depending on the quantity of articles returned, some searches were expanded with supplementary terms and some were limited to reviews, latest research and references with abstracts. Results of the searches were screened for eligibility, the inclusion criteria used was original research, policy directives, reviews of research and expert opinion. Hand searching involved reviewing the monthly editions of Infection Control Medline Updates produced by the British Library (1994-1999). Abstracting journals were accessed and reviewed: Nursing Research Abstracts, AJN International Nursing Index, RCN Nursing bibliography, Index Medicus, Current Advances Series and Current Context Clinical Practice. Hand searching of key journals included: Journal of Hospital Infection, Nursing Times, Nursing Standard, Nursing Research, Nurse Researcher and the Journal of Advanced Nursing. Selective hand searching of specialist journals were made when available: British Medical Journal, Lancet, British Journal of Anaesthesia, British Journal of Intensive Care, Intensive Care and Critical Care Nursing, Annals of the Royal College of Surgeons of England, Infection Control and Hospital Epidemiology, American Journal of Infection Control, Reviews of Infectious Diseases, Hospital Infection Control, Heart and Lung, Critical Care Quarterly, American Journal of Critical Care, Advanced Nursing Science and Western Journal of Nursing Research. Studies that appeared to meet the review criteria were appraised, the contribution to the review identified, results were synthesised, presented and are discussed.

2.1 Background

Epidemiology and use of statistics

In the mid-1800s Semmelweis applied scientific principles to study the aetiology, concept and prophylaxis of puerperal (streptococcal) fever. He demonstrated the role of hands in the transmission of infection before bacteria were discovered (Wyklicky and Skopec 1983; Newsom 1993; LaForce 1993; Horton and Parker 1997). Semmelweis was the first person to conduct case controlled studies, providing the basis for present-day epidemiology. He observed that the major risk factor for maternal infection was prolonged labour in hospital. Babies of mothers with puerperal fever were more likely to become ill, but street births carried reduced risk. LaForce (1993) described the organisation of maternity care in Vienna at the time. The Vienna "Lying-in" hospital was divided in two divisions; the first was a medical student teaching service and midwife trainees staffed the second. Admissions alternated between divisions every 24 hours. Semmelweis reviewed maternal deaths in the two divisions and found that while 10% of women delivered by physicians and medical students died, only 3% of women delivered by midwives died. A further key observation led Semmelweis to formulate his hypothesis. Semmelweis' friend, Professor Kolletschka, died of sepsis after sustaining an injury to his finger from a medical student's knife during an autopsy. Semmelweis reviewed the records of Kolletschka's autopsy and noted his symptoms were similar to those seen in women dying from puerperal fever. Semmelweis concluded that the hands of doctors and medical students that were contaminated in the autopsy room caused puerperal sepsis. He hypothesised that disinfection of hands could break transmission of disease from cadavers to pregnant women. In 1847 he introduced handwashing with chlorinated lime solution before manual examination of women and in the following year mortality figures had reduced to 1.3% in the medical division and 1.2% in the division staffed by midwives.

During the same time period the risk of general post-operative infection in hospitals was high (LaForce 1993; Horton and Parker 1997). Dr. James Simpson conducted a survey in 1860 on patient mortality rates following leg amputation. He was concerned that operations conducted in large municipal hospitals were increasing patient mortality. He compared mortality after leg amputation in patients' own homes carried out by country practitioners and those carried out in 11 large metropolitan hospitals. Simpson found that country practitioners' operations were five times more likely to be successful and infection accounted for 60% of deaths in large hospitals (Bartzokas *et*

al. 1995). Simpson explained his observation as *"hospitalism"* suggesting that some factor related to hospital care caused increased risk of mortality for patients. Florence Nightingale's campaign in the Crimea reduced mortality through provision of safe food & water, a clean environment and a standardised reporting system for army deaths (Laforce 1993). Nightingale suggested a direct relationship between sanitary conditions and post-operative infectious complications. She collaborated with William Farr, the Registrar General, in statistical interpretation of health data from the English principal hospitals in 1863. Nightingale suggested that hospitals should maintain a comprehensive reporting system for deaths in hospital and that ward sisters should maintain these records. Lister introduced the principles of antisepsis - using clean instruments & carbolic acid - in 1867 (Laforce 1993; Bartzokas *et al.* 1995). Following this Lister reduced mortality after leg amputation in a Glasgow hospital from 46% to 15%. The application of the aseptic technique brought surgical wound infections under control (LaForce 1993), but few statistical data were published. Meleney, an American doctor, (cited by LaForce 1993) emphasised the need to keep records and developed an active surveillance system for surgical wound infections. His results showed surgical wound infections decreased from 14.0% in 1925 to 4.8% in 1933 (LaForce 1993), thus demonstrating the benefits of systematic data collection.

Development of antibiotics

Levy (1992) described the development of antibiotics as a major advance in the prevention of hospital infections, with staphylococcal and streptococcal infections being controlled by the introduction of sulphonamides in 1935. The First World War saw the introduction of penicillin - and this was viewed as a *"golden era"* with the successful prevention of septicaemia. During the 1950s there were severe epidemics of hospital-acquired staphylococcal infections in both Europe and America, this pandemic being the main impetus for development of hospital epidemiologists in USA today (LaForce 1993). Laforce (1993) reflected on the progress made over 150 years of organised health care and concluded that, *"individuals who not only have good ideas but the energy to test their concepts and analyse their results have the greatest role in this success".* Antibiotics continue to be our major therapeutic resource for curing and preventing infections (Levy 1992). The introduction of antibiotics in the 1940s revolutionised the treatment of human infections and the success of antibiotics continued to prompt their immediate use when an infectious bacterial cause is suspected. From the 1960s antibiotics began to be used for prophylaxis, that is to prevent infection rather than as a therapy to treat an established infection.

A problem that has plagued antibiotic therapy from the earliest days of their use is the resistance that bacteria can develop to the drugs being used. An antibiotic may kill most of the bacteria causing a disease in a patient, but a few bacteria that are genetically less vulnerable to the effects of the drug may survive. These go on to reproduce or to transfer their resistance to other bacteria. With their more vulnerable competitors wiped out or reduced in numbers by antibiotics, these resistant strains proliferate. The result is bacterial infections in humans that are untreatable by one or even several of the antibiotics that would normally be effective. The indiscriminate and inexact use of antibiotics encourages the spread of such bacterial resistance. Levy (1992) emphasised that most bacteria that were previously universally susceptible to antibiotics are resistant to at least some, if not many different ones.

Infection in the hospital environment

Healthy people carry millions of bacteria on the surface of their body, on their skin, in their noses, mouths, respiratory tract, genito-urinary tract and bowel. If bacteria enter a normally sterile part of the body of a healthy individual, the body has various mechanisms for natural resistance to these bacteria and infection does not usually occur. The hospital environment differs from the home or community environment in three ways. There is a higher concentration of microbes, a higher proportion of bacteria that are, or can easily become, resistant to antibiotics and a higher proportion of susceptible hosts. Today's hospitals are modern, large, complex institutions containing a high concentration of patients with an infection and compromised individuals at risk of acquiring infection (Inglis 1996). There are many locations in hospitals that may be contaminated with potential microbial pathogens, but it is the staff and patients that serve as the principal sources (Inglis 1996).

Sources of hospital-acquired infection

Infections are inseparable from life, but they are more common and more severe in hospitals than elsewhere. Some patients come into hospital for the treatment of established infections and others are debilitated by non-infectious illness. Treatment commonly causes further debility and a situation occurs when patients with infections are cared for in close proximity with those patients who are more likely to acquire them. Micro-organisms can be transmitted to patients by a variety of routes including direct contact, indirect contact from one patient to another, by the air-borne route, by ingestion or by inoculation.

Patient-related risks of acquiring hospital-acquired infection

When people enter hospital as patients they may have increased risks of developing an infection such as severe underlying illness, poor general health or a condition that requires invasive treatment or therapy. In these circumstances the patient's own normal resistance to infection can be decreased. Severe illness, underlying diseases, treatment with antimicrobial drugs, exposure to antiseptics and change in nutritional status all upset the balance of normal resident bacteria. This is why most patients add hospital microbes to their normal flora soon after they are admitted to hospital. These hospital bacteria are adapted to the unique environment of the hospital, are more resistant to antimicrobial drugs and can easily become opportunistic pathogens causing infection.

Treatment or therapy related risks for acquiring hospital-acquired infection

A feature of hospital treatment is the frequency that invasive therapy or medical devices by-pass normal defensive barriers to infection. They allow microbes to penetrate the normal defences to infection causing bacterial colonisation and infection in places otherwise inaccessible to them. Virulence of microbes can range from the low virulence of commensal micro-organisms to the high virulence of pathogenic micro-organisms. Those in the intermediate range are potential or opportunistic pathogens. Fully virulent organisms cause infections in healthy people. To do so they must be introduced in sufficient numbers by the correct route. The defences of the body can repel large numbers of bacteria, e.g. one million *Staphylococcus aureus* must be injected into healthy skin to produce a small pustule, 10 million painted on to intact skin do not have an effect. This response changes if immunity is compromised, e.g. 100 *Staphyloccus aureus* on a suture will produce a stitch abscess.

Hospital-acquired infection

Hospital-acquired infection is commonly caused by bacteria already established in large numbers on the body surfaces of patients and hospital staff. In consequence, these bacteria are poised to take advantage of even small local failures of immunity. On the body, microbial life spans are measured in minutes - in a few hours, healthy normal resident flora can become unhealthy. The most common micro-organisms associated with hospital infections are bacteria, fungi and viruses. Bacteria cause most of the infections that develop in hospital, with viruses and fungi next in importance. In order to invade living human tissues, bacteria must breach the normal barriers to infection and then spread by direct expansion, along tissue planes or via the veins and lymphatic vessels. The outcome of a bacterial invasion of a new host depends upon three factors: host resistance, the virulence of the microbe, and the infective dose.

Treatment of hospital-acquired infections

Infections that develop are generally treated with antimicrobial drugs. The scale of the problem is such that at any one time at least 20% of patients in hospitals are receiving these drugs. Hospital-acquired infections are more likely to be caused by antibiotic-resistant strains, making failure of the first choice of therapy more likely. Bacteria rapidly adapt to the environment by developing resistance to the antimicrobials in use; *"hospital strains"* of bacteria emerge to multiply vigorously in the fertile environment that is provided for them. Hospitals provide an environment in which antibiotic-resistant strains collect, concentrate and are maintained by a higher level of antibiotic usage than is normally found in the community. Acquired resistance to antimicrobial agents is more common in micro-organisms isolated from hospital patients than in organisms causing community-acquired infections. Even if the optimal agents are given by the best route, patients may take longer to respond to antimicrobial treatment because of compromised host defences, or possibly the presence of an indwelling medical device.

Hospital-acquired infection: case definition

An essential part of any epidemiological study is a careful definition of the phenomenon being measured (Meers *et al.* 1997). The most recent definitions for hospital-acquired infection used in the UK were developed for the Department of Health funded study conducted by the Public Health Laboratory Service of infection control audit in 19 district general hospitals (Glynn *et al.* 1997). Definitions used in the UK have been adapted over time from previously published criteria and have been used for discreet projects, but are not applied in routine clinical practice. Glynn *et al.* (1997) found difficulty in developing definitions for hospital-acquired infections that were easy to interpret and use, yet remained acceptable to clinicians. They recommended that a working group be established to standardise nationally agreed definitions as an essential prerequisite for efficiency and comparability of data (Glynn *et al.* 1997).

A national programme has commenced but currently there is no professional consensus for definitions of hospital-acquired infection in the UK (Department of Health 1995, Crowe and Cooke 1998). Crowe and Cooke (1998) described the consultation process being used to develop nationally agreed definitions to support the UK Nosocomial Infection National Surveillance Scheme (NINNS). They reviewed generic statements for hospital-acquired infection from four expert groups and although they identified large consensus, there were important areas of variation.

Surveillance of hospital-acquired infection

Choice for surveillance of hospital-acquired infection is determined by: the scope of the infection control programme, the value of active versus passive techniques, the role of retrospective versus prospective data collection and whether a patient-based or laboratory-based system should be selected (Perl 1993). The objective of the study and the resources available in terms of money, time, expertise and numbers of personnel available determine choice. From this point, surveillance methods are similar and include: defining categories of infection, systematically finding and collecting data, tabulating data, analysing and interpreting data, reporting relevant infection surveillance data and implementing any appropriate actions (Perl 1993).

Measuring hospital-acquired infection

Incidence rates of hospital-acquired infection are generally thought to be more useful in reflecting the true nature of the problem of hospital-acquired infection, but are expensive, time consuming and difficult to administer (Glenister *et al.* 1992a, Perl 1993). This method of surveillance involves systematic data collection that determines the number of new infections in a given population during a specific period of time. Incidence rates are tallied for infections rather than for infected patients as the latter may underestimate the infection rate (Perl 1993). Incidence results are not affected by the differences in duration of infections or affected by seasonal changes. Prevalence studies are conducted by random surveys and are simpler to administer than incidence studies. Prevalence studies either measure the number of people with an infection or the number of infections that are present at a given time or period (Glenister *et al.* 1992a). Prevalence studies have been shown to be a cost-effective method of raising awareness to the problem of hospital-acquired infection and a means of auditing the effectiveness of infection control programmes (French *et al.* 1989; French and Cheng 1991). The main disadvantage of prevalence studies is that the duration of the patient's hospital stay influences and complicates the interpretation of results (Perl 1993).

Epidemic hospital infection

An outbreak of infection, or hospital epidemic, implies that existing preventative measures are inadequate (Inglis 1996). Epidemics account for only 5% of all hospital-acquired infections (Meers *et al.* 1997), but are an important medical problem (Doebelling 1993). Definitions of an epidemic in UK publications differ slightly than those in the USA. Mehtar (1992) defined an infection outbreak as, *"an increase in the isolation rate of a particular organism or any clustering of clinical cases".* Inglis (1996)

defined an epidemic as an event when a given communicable disease is, *"present in a particular group at a higher than normal rate".* These definitions contrast with the precise definition given by Doebelling (1993), an American Epidemiologist. He defined an epidemic or outbreak of hospital-acquired infection as a *"statistically significant (p=<0.05) increase in the incidence of specific infection above that noted previously in a certain patient population".* Doebelling's definition can be so precise because in the USA the background rate of hospital-acquired infection is generally known, whilst in the UK it is not (Inglis 1996).

Endemic hospital infection

Endemic infections are those infections that are constantly present in a particular population with very little variation in rate (Inglis 1996), such as respiratory infection, surgical wound infection and urinary tract infection, which often go unrecognised (Stamm 1981). Endemic infections are believed to account for more than 95% of infections acquired in hospital and form a continuous and an *"all-too-often ignored ground swell that runs through every hospital"* (Meers *et al.* 1997). Multiple-resistant strains of hospital-acquired pathogens may be endemic, especially in large teaching hospitals and these strains may be transmitted from patient-to-patient in mini-outbreaks (Inglis 1996). Outbreaks of common endemic hospital-acquired infections remain unrecognised because of difficulties in distinguishing small clusters of related infection from on-going background infections (Stamm *et al.* 1981).

Monitoring hospital infection in the UK

Glynn *et al.* (1997) regarded the current UK systems for monitoring hospital infection as *"making good use of laboratory data and of the limited infection control personnel".* Infection Control Teams in the UK routinely note the appearance of specific *"alert organisms"* (named organisms which might cause cross-infection problems) and outbreaks of highly contagious infectious conditions, these are then dealt with promptly and contained. However, Glynn *et al.* (1997) criticised the *"reactive"* nature of the UK system and highlighted that little attention is paid to producing incidence, or even prevalence rates of hospital-acquired infection.

> *"Such rates are not theoretical niceties. It is a long standing paradox that, given their limited resources and the work involved in collecting proper denominator data, ICTs [Infection Control Teams] frequently cannot calculate adequate rates, or respond to them if they could. Yet it is only by the evidence of such rates that they can judge the effectiveness of their teaching and surveillance and justify requests for more help"*
>
> Glynn *et al.* 1997

2.2 Impact of hospital-acquired infection

Infections acquired in hospital complicate illness, cause discomfort & anxiety and lead to death, yet studies rarely take into account the direct and indirect costs to patients and those who care for them (Plowman *et al.* 1997). Patients may need to be isolated in a side room after acquiring a hospital infection, but little is known about the psychological effects of isolation (Gammon 1999). Limited research has shown that patients feel psychologically and socially isolated; have increased anxiety and depression; frequently express anger or fear and complain of feeling *"dirty"* (MacKenzie 1997). Media campaigns have highlighted public concerns about hospital-acquired infection (Consumer Association 1990; Dawe 1992; Naish 1992; O'Bryne 1992; Observer Magazine 1992). In 1992, as a result of a radio talk show, an appeal was made for information from patients who had contracted infections in hospital (Naish 1992). The Nursing Standard telephone switchboard was jammed. Patients made comments about experiencing increased pain, the need for repeated operations, poor hygienic conditions in hospitals, patients having to clean the toilets & baths before use and a patient having to shout at a doctor to hand wash before removing a dressing. In 1996 Channel 4 television presented *"Cutting Edge"* that highlighted an incidence of cross-infection of multi-resistant tuberculosis (Lords Hansard 1996). A similar media campaign was repeated in the Daily Mail during 1998 and more recently headlines such as *"Hospital makes one in ten sick"* (BBC News, June 3rd 1998) and *"even Diana failed the hospital hygiene test"* appear on the BBC news internet service (BBC News, July 9th 1998). An information sheet accessed from the World Wide Web (International Family Entertainment 1996) asked *"Are hospitals making you sick?"* The information sheet highlighted that more Americans die from hospital infections than from *"car wrecks and homicides combined"* and it is likely that a similar situation may be occurring in the UK (Plowman *et al.* 1997).

Costs of hospital-acquired infection

As the cost of health care has risen there is increasing interest in the effectiveness and efficiency of health care delivery (Wakefield 1993). Controlled studies have shown that costs of hospital-acquired infection can be high. Costs can range from £1041 per patient for all infections in surgical patients up to £25,753 per patient for survivors of bloodstream infections in surgical intensive care unit patients (Department of Health 1995). Costs to the NHS in the UK have been estimated to be from £115,000,000 (Currie and Maynard 1989) to as much as £650,000,000 (Selwyn 1991). Currie and Maynard (1989) calculated that if effective infection control reduced hospital-acquired

infection by 32%, the potential reduction of costs would be £30,000,000 per year. After the costs of providing the necessary infection control services and personnel were deducted, the *"savings"* could be in the region of £15,600,000. In one study the costs of an effective infection control programme were calculated at 1.25% of the savings achieved (French and Cheng 1991). The impact of the research was calculated as saving 42,000 bed days, reducing expenditure on antibiotics and saving 130 lives. French and Cheng (1991) regarded that the costs of the infection control programme were negligible when compared with improved quality. Daschner (1989) described a cost-benefit study of hospital infection control conducted in Germany. His results showed that although hospital-acquired infection control is expensive, it is cost-effective. Daschner (1989) championed an environmentally sensitive approach to infection control and believed that many infection control procedures could be provided at a lower price but with the same effort and effects.

The drive for high quality, cost-effective care has become stronger and more urgent. The NHS is required to increase activity and quality of care with fewer resources. Caring for infected patients places higher demands in terms of time, resources used, intensity of care and stress. However, to date, we have gained only a partial understanding of and appreciation for the total economic consequences of hospital-acquired infection (Wakefield 1993). Wakefield attributed this partial understanding to three broad methodological issues related to hospital-acquired infection:

- problems with identification
- problems with determining direct causes
- problems with data analysis

In the USA, studies have tended to include only direct costs associated with hospital-acquired infection diagnosis and treatment. None of the potential indirect or future costs have been measured (Wakefield 1993). The direct costs of hospital-acquired infection can be attributed to increased bed occupancy, increased nursing & medical time, extra use of pharmaceuticals and medical equipment. Indirect costs of hospital-acquired infection are more difficult to identify. Examples are: microbiological investigations, sterile supplies, infection control services and the provision of isolation facilities. Currie and Maynard (1989) suggested that reduction in hospital infection rates could release resources that could be re-directed in the NHS. The Association of Medical Microbiologists published their report on *Cost Implications of Infection Control* (Mehtar *et al.* 1991). The report suggested protected funding for maintaining

established infection control services and meeting the costs of hospital-acquired infection outbreaks. The report also emphasised the value of hospital infection control in realising financial benefits to the hospital. Economic analyses to date have only used data extrapolated from other countries (Currie and Maynard 1989; Drummond and Davies 1991;Plowman *et al.* 1997). Their calculations indicated that moderately effective infection control programmes would quickly repay any initial investments made, but primary research in the UK in this field is missing.

The economic impact on individuals in terms of the effects of morbidity and mortality associated with hospital-acquired infection in the UK remains unmeasured. Plowman *et al.* (1997) showed that hospital-acquired infection in the USA ranks fourth as the *"main cause of or contributing importantly to death"* and eleventh as the main cause of death. Using extrapolated data (Department of Health 1995) and assuming a similar mortality rate in the UK with that in the USA, Plowman *et al.* (1997) calculated that, in the UK during 1993, 5,000 deaths might be primarily attributed to hospital-acquired infection. In a further 15,000 cases hospital-acquired infection might be a substantial contributor to a patient's death. From this, the authors concluded that hospital-acquired infection is a more common primary cause of death in the UK than road accidents or suicides. The cost for *"loss of life"* of the 5,000 deaths primarily attributed to hospital-acquired infection in the UK during 1993 was calculated at £4.2 billion. (Plowman *et al.* 1997).

2.3 Development of health policy

The Medical Advisory Committee of the Central Health Services Council published a report in 1959 *'Staphylococcal Infections in Hospitals'* (Ministry of Health 1959). The report highlighted that the true extent of the problem of staphylococcal infection may be overlooked if hospitals did not have adequate systems for recording infections. They recommended vigilance in detecting clinical signs of infection in patients and that the nursing sister in charge of the ward or department should maintain a Control of Infection Register. Since then official recommendations have been made relating to the prevention, diagnosis and treatment of infection, with a large number of UK laws, guidance and recommendations being made relating to the prevention, diagnosis and treatment of infection (Medical Research Council 1941; Medical Research Council 1944; Ministry of Health 1951; Ministry of Health 1959; Council of Europe 1983; Council of Europe 1985; Department of Health and Social Security 1988a; Department of Health and Social Security 1988b; Department of Health 1991a; Department of Health 1991b; Department of Health 1991c; Department of Health 1995; House of

Lords Science and Technology Committee 1998; Standing Medical Advisory Committee 1998). Current legislation and local regulations are generally concerned with the control of communicable disease and control of outbreaks in institutions. *'Public Health in England'* (Department of Health and Social Security 1988a) examined amongst other health issues, the problem of control of communicable disease. Sir Donald Acheson, Chief Medical Officer at the time, commented on the complexity of public health legislation relating to protection of individuals and communities from the hazards of infection. The NHS Act 1977 made health authorities responsible for the range of services contributing to prevention, control and treatment of communicable disease and infection. The consolidatory 1984 Public Health (Control of Disease) Act drew together in one statute, complex legislation that had been enacted over the previous one hundred years (Department of Health and Social Security 1988a). Acheson recommended that the 1984 Act should be revised with a view to producing a more up-to-date and relevant legislative backing to the control of communicable disease and infection. A joint Hospital Working Group was set up by the Department of Health and Social Security and the Public Health Laboratory Service to consider revision on guidance for the control of infection in NHS hospitals. Guidance on the control of infection in hospital was drawn up by the Hospital Infection Working Group (Department of Health and Social Security 1988b). The report made recommendations for the management and organisation of infection control services in the UK, which are still valid to this day, but the adoption has not been universal (Department of Health 1995).

The consultative document *'Health of the Nation'* (Department of Health 1991a) suggested that there was scope for setting targets for reducing hospital infection. However, accepting that the rate of hospital-acquired infection remained a serious problem, the white paper (Department of Health 1992) did not include reduction of hospital-acquired infection as a target, but referred this issue to the Clinical Standards Advisory Group (National Association of Health Authorities and Trusts 1992) to provide further advice. As a consequence a number of national reports, studies and projects were commissioned (NHS Executive 1994; Glynn *et al.* 1997; Plowman *et al.* 1997). The report from the joint Hospital Infection Working Party gave comprehensive national guidance using the updated research base (Department of Health 1995) and the report was accepted as Department of Health policy (NHS Executive 1995). Standards and guidelines for infection control and infection control practice were published (Infection Control Standards Working Party 1993; Royal College of Nursing 1995; Ward *et al.* 1997).

The Department of Health commissioned a Public Health Laboratory Service (PHLS) study of infection control activity in 19 district general hospitals (Glynn *et al.* 1997). From March 1996, the Department of Health has funded a Nosocomial Infection National Surveillance Scheme (NINSS) in the UK. The scheme is based in the Nosocomial Infection Surveillance Unit (NISU) at the PHLS Central Public Health Laboratory, Colindale, London. The NISU brings together microbiological, epidemiological, nursing, information technology and statistical expertise (Public Health Laboratory Service 1999; Crowe and Cooke 1998). The House of Lords Science and Technology Committee (1998) visited the Communicable Disease Centre (CDC) in the United States of America (USA) and were able to compare the National Nosocomial Infection Surveillance (NNIS) approach used in the USA with the newly established UK system. Both systems are using confidential reporting systems, both returning results to each hospital and providing comparisons in data in relation to the overall distribution of infection in participating hospitals. In 1998 the UK NINSS involved 150 hospitals in England and the scheme included surveillance of blood stream and surgical wound infections (House of Lords Science and Technology Committee 1998). In the USA 250 hospitals are involved in the NNIS programme, but in addition they have a system called Intensive Care Antibiotic Resistance Epidemiology (ICARE). ICARE takes the NNIS data and adds information about antibiotic usage. In 1998 the ICARE scheme involved 40 hospitals, each of which received a nominal $3-4,000 to support data collection; it covered 13 *"bug-drug"* combinations, chosen for their clinical importance. When returning results to each hospital, the ICARE team at the CDC identify interventions that could bring down rates of bacterial resistance to antibiotics. The House of Lords Science and Technology Committee highly recommended the ICARE project and considered how a project of this type could be introduced in the UK. The House of Lords Science and Technology Committee, (1998) highlighted that although the UK NINSS is newly established and less well developed than the US NNIS, the PHLS was currently experiencing a reduction in funding from the Department of Health.

2.4 Evidence based health care

Evidence based practice has been defined as the integration of individual clinical expertise with the best available external evidence from systematic research (Sackett *et al.* 1996). However, using more practical terms, evidence-based practice can also be defined as a process of turning clinical problems into questions and then systematically locating, appraising and using, *"research findings as a basis for clinical decisions"* (Deighan and Boyd 1996). The NHS Research and Development strategy aims to create a knowledge-based health service in which clinical, managerial and policy decisions are based on sound information about research findings and scientific developments (Department of Health 1998). Evidence based practice requires that clinicians obtain evidence, implement the evidence and evaluate the effect this has on patients and resource usage. Improving the clinical effectiveness of services is one of the major challenges currently facing the NHS (Moores 1997). There is a clear relationship between research and audit and it is important to understand their differences. Research is concerned with discovering the right thing to do, whilst audit is concerned with ensuring that it is done in the right way. The Effective Health Care Bulletin – *Getting Evidence in Practice* (NHS Centre for Reviews and Dissemination 1999) reviewed the literature and discussed the results in the context of current UK health policy. The review indicated that dissemination activities are relatively ineffective in directly changing behaviour and the authors emphasised gaps in the literature. Results suggested that promotion of effectiveness and improvement in quality will only be achieved if relevant research findings and valid guideline recommendations are appropriately incorporated in practice, but *"often this will necessitate a change in behaviour on the part of relevant health professionals".* The report emphasised that achieving change is difficult and *"the complexity of changing behaviour is well recognised".* Further research is required into methods of effective dissemination which will ensure dissemination activities are assessed against certain outcomes such as knowledge, beliefs and attitudes. With respect to implementation, the review suggested that the ultimate aim is to develop an empirical basis for choosing interventions in the face of specific barriers to evidence based practice, requiring both quantitative and qualitative methods to judge *"not just the effectiveness of interventions, but gain an understanding of the process of professional behaviour change".* Finally the review suggested that greater insight is needed into the *"personal skills and attributes that influence the effectiveness of individuals involved in changing behaviour"* (NHS Centre for Reviews and Dissemination 1999).

2.5 Risk Management

Bowden (1997) has written extensively on risk management in the NHS. He suggested that recent changes in the organisation of the NHS will give more power to clinicians, with outcomes of health care taking precedence over outputs. He highlighted research undertaken in the USA and Australia which estimated that in a hospital with 500,000 admissions per annum, there could be between 2,000 and 8,000 adverse events leading to either injury or longer hospital stay. He suggests that associated risks, *"like change itself"*, are inevitable and *"that NHS Trusts and health authorities need to be sure that risks are identified, assessed and managed explicitly, with a view to their reduction and control"*. Risk management is an essential component of quality systems and a fundamental part of a total approach to quality improvement (Department of Health 1993). Chesworth (1999) discussed risk management in relation to infection control. She emphasised that health care litigation is on the increase and Trusts are expected to implement risk management to reduce claims of clinical negligence. She conducted a telephone survey of NHS Trusts and found that most had designated Risk Managers, but their involvement with Infection Control Nurses was minimal. She followed up the telephone survey with a detailed postal survey to a random sample of Trusts in the UK. Recognition of infection control expertise in organisational risk management was acknowledged by only 33% of respondents.

2.6 Infection control and the law

Tingle (1997a) stated that in the UK *"healthcare litigation remains on the increase and will continue to rise at nearly 25% per annum."* The recent high profile of adverse event reporting in the NHS and the introduction of clinical governance may contribute to a changing public attitude to their expectations for standards of healthcare. The UKCC regard record keeping as *"an integral part of nursing [...] a tool of professional practice and one which should help the care process"* (UKCC 1998). The guidelines for standards for nursing records and record keeping stated that records should provide clear evidence of the care planned, the decisions made, the care delivered and the information shared. The UKCC guidelines drew attention to the standard approach that courts of law tend to take; *"if it is not recorded, it has not been done"*. In a Department of Health press release (Department of Health 1998d), Frank Dobson, Minister for Health, asked for advice how to *"tackle the rising levels of litigation in the health service"*. He particularly asked for suggestions to reduce the number of incidents that might lead to a claim against the NHS; he added that the obvious approach was to reduce poor and ineffective care.

Using clinical practice guidelines has been suggested as a way to protecting both patients and healthcare professionals. Guidelines are systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances (NHS Executive 1996). Use of clinical practice guidelines were discussed in an Effective Health Care Bulletin (NHS Centre for Reviews and Dissemination 1994). In reference to clinicians' concerns about the legal status of guidelines and potential litigation in cases of non-compliance, the reviewers discussed the Bolam test, which is the legal test case for litigation within the NHS. As the basis for negligence cases, it uses the criterion of *"common professional adoption"*, rather than that of evidence-based health care. This means that guidelines that fail to reflect customary practice, however scientific, are likely to fail the Bolam Test (NHS Centre for Reviews and Dissemination 1994). However, the expected standard of skill and care is determined by reference to the state of medical knowledge and science at the time of the incident and the *"court is the final arbiter of a professional standard"* (NHS Executive 1993).

Herwaldt (1993) discussed the social, political, economic and legal issues affecting infection control and highlighted the increasing public expectation of standards in healthcare. She believed we were in an *"era of assessment and accountability"*, which has developed naturally from the era of cost containment, imposed largely because of social pressures. Herwaldt described how in the USA legal action has been invoked by hospital-acquired infection with lawyers successfully obtaining records of infection control committees. Herwaldt, an American epidemiologist, emphasised that as

> *"as new technologies are absorbed into practice, we would do well to reinforce the traditional aspects of infection control. Surveillance for, and reporting of, nosocomial infections remain the foundation of our practice and are important legal obligations."*
>
> Herwaldt 1993

2.7 Standards of clinical documentation

Two PHLS studies of infection control in the UK (Glenister *et al.* 1992; Glynn *et al.* 1997) have discussed the quality of clinical documentation of infection and infection control. Glenister *et al.* (1992) studied the effectiveness of surveillance methods for detecting hospital infections and found that few hospital-acquired infections were identified from nursing notes or laboratory request forms,

> " [...] *it appeared from the findings that nursing and medical notes do not record accurately the symptoms and signs experienced by the patient. The extent of this deficiency is unknown and it would be useful to establish and consider ways of improving the assessment and documentation of symptoms and signs of infection [...]"*
>
> Glenister *et al.* 1992

Glenister *et al.* (1992) proposed improvements should be made in documentation of symptoms & signs of infection and suggested that with advances in information technology in the health service, the process of collecting data about infections should become more effective and efficient in the future (Glenister *et al.* 1992). By the time of the second PHLS study, the standard of documentation had not improved. This study was conducted from 1994 to 1995 and reported in 1997 (Glynn *et al.* 1997). The research team studied hospital-acquired infection in 19 district general hospitals and found that infections were infrequently mentioned in medical notes, or they were queried but not subsequently confirmed.

Finn (1997a;1997b) undertook a small Action Research study to establish how infection control advice was documented and to assess the effectiveness of the provision of an example infection control care plan. Infection control precautions were documented for less than 25% of cases. Provision of an example care plan together with guidance on its use was followed by an increase in documentation for all items audited with statistically significant increase of infection identification in the care plan. However, in spite of this improvement documentation of appropriate care for control of infection remained inadequate. Finn (1997b) concluded that, *"while various strategies to effect change are at the Infection Control Nurse's disposal, the need to integrate infection control with practice must be addressed at every level to include managers, educators and practitioners".*

2.8 Infection control policies and practice

Taylor (1992) considered that qualified nurses seldom look at infection control policies and suggested that the difficulties of infection control policy development and use should be addressed explicitly. Taylor believed that infection control is often perceived as *"rules and routines"* that are grafted on to a care plan, whereas in reality infection prevention and control is the basis of all care. Taylor believed that efforts to resolve conflicts have resulted in individuals returning to basic principles of infection control without formal guidance, however this has caused difficulties and confusion. In addition to surveillance of hospital-acquired infection and risk factors for infection, Glynn *et al.* (1997) conducted an analysis of infection control policies and practices. Infection control content of local policies included those for prevention of urinary tract infection, bloodstream infection and lower respiratory tract infection. Statements from the infection control policies used at the 19 district general hospitals involved in the study were identified, the frequency with which each was cited was calculated. The Infection control teams from each of 19 hospitals were then asked to consider the statements and decide how important each was for the prevention of infection by categorising them as *'essential', 'desirable', 'optional'* or *'not important'.* Twelve infection control teams provided responses for each of the policies reviewed and these were analysed to provide weighting for each statement. Results showed that, although washing hands is considered an essential component of infection control, there were infrequent references to it in the policies analysed, especially after completion of a procedure. Staff infection practices were observed and compliance to policies noted. Over half of staff asked did not know there was a policy relevant to what they were doing. Some staff indicated that they knew there was a policy but did not know where to find it, some that they washed hands for longer when being observed, some that they sometimes skimped on handwashing and some that the quality of handwash depended on the task just completed. Results showed that there was poor compliance with policies, there were staff idiosyncrasies and that staff were loyal to policies of their previous hospital or early training. Some infection control policies were in need of revision and Glynn *et al.* (1997) noted that there was need for some generally accepted infection control guidelines for a number of common procedures.

Hands as vectors of infection

Casewell and Philips (1977) found that 17% of staff of an intensive care unit were found to have bacteria *Klebsiella* sp. contaminating their hands. These strains could be related to the bacteria infecting or colonising patients in the unit on the same day. Introduction of routine handwashing was associated with a significant and sustained

reduction in the number of patients colonised or infected with *Klebsiella* spp. Burnie (1986) discussed the carriage of yeasts and *Candida* species on the hands of staff working in intensive care units. Systemic candiosis is a fungal infection of increasing incidence with a high mortality. Burnie investigated an outbreak of systemic candidosis in 13 patients in an intensive care unit, but found no environmental source. The strain of yeast was cultured from the mouths of four nurses and on the hands of one of these nurses. Burnie proposed that hand transmission was important in development of pathogenic candidosis. Horn *et al.* (1988) investigated the composition and antibiotic sensitivity pattern of bacteria recovered from the hands of nurses and physicians in two service units of a major teaching hospital as compared with those found in a control population. Significant differences in the composition of bacteria were found in dermatology and oncology unit personnel. *S. aureus* was recovered from 31% of dermatology nurses and 37% of dermatology physicians, and 17% of controls. Oncology personnel had a significantly higher carriage of gram-negative bacteria, yeast and multiple antibiotic-resistant bacteria. Both dermatology and oncology nursing personnel were colonised by organisms resistant to multiple antibiotics. Methicillin resistance was found in 26% and 66% of the staphylococci recovered from dermatology and oncology nurses respectively. McGinley *et al.* (1988) showed there were significant quantitative differences in the composition and density of microflora in different areas of the hands of 26 adult volunteers. The subungual spaces (the space under the fingernails) had a higher number of bacteria compared with other hand sites. Sneddon (1990) studied carriage of Gram-negative bacilli on nurses' hands. She studied 50 nurses' hands during their normal activities. Handwashing techniques were scored out of a maximum 20 points. Results showed only 52% of handwashes by nurses were considered *"good"*. Gram negative bacilli were isolated on hands before handwashing in 46% of the sample. One nurse did not have Gram-negatives on hands before washing, but did after handwashing. Seventy-eight per cent of nurses turned off elbow taps using their hands, a major cause of contamination of clean hands and a potential cause of cross-infection.

Bauer *et al.* (1990) conducted a prospective epidemiological study to assess the relative importance of airborne and direct contact transmission of micro-organisms in an intensive care unit. The survey was carried out over a seven week period. Bacteria from staff, patients and the air were monitored. Transmission of isolated micro-organisms was followed. Handwashing samples revealed pathogenic bacteria in 31% of doctors and 17% of nurses. Air cultures yielded pathogens in 15% of sampling periods. Nine of the 53 patients were found to be colonised with Gram-negative

bacteria, *Staphylococcus aureus* and *Candida spp*. The spectrum of bacteria recovered from patients and the air was generally different, whereas strains recovered from patients and their attendants' hands were indistinguishable on multiple occasions. Results confirmed that direct contact is the principal pathway of microbial transmission. Noskin *et al.* (1995) investigated the recovery of vancomycin-resistant enterococci (VRE) on fingertips and environmental surfaces and observed the importance of handwashing on the removal of these organisms. In experimental conditions, two clinical isolates of VRE (Enterococcus faecalis and Enterococcus faecium) were inoculated on to the hands of healthy human volunteers and on the following environmental surfaces: countertops, bedrails, telephones and stethoscopes. Following inoculation, samples were obtained at various time intervals to determine rates of recovery of organisms. To evaluate the effects of handwashing on enterococcal recovery, hands were washed with either water or water plus with soap. The soap and water studies were performed with a 5-second and a 30-second wash. Both enterococcal strains survived for at least 60 minutes on gloved and ungloved fingertips. The E. faecalis was recoverable from countertops for 5 days; the E. faecium persisted for 7 days. For bedrails, both enterococcal species survived for 24 hours without significant reduction in colony counts. The bacteria persisted for 60 minutes on the telephone hand piece and for 30 minutes on the diaphragmatic surface of the stethoscope. A 5-second wash with water alone resulted in virtually no change in recovery of enterococci; a 30-second wash with water plus soap was necessary to eradicate the bacteria from hands completely. Becks *et al.* (1995) described a prolonged outbreak of *Pseudomonas aeruginosa* in a neonatal intensive care unit. The attack rate of this outbreak was 8.5% with no associated mortality. Hand lotion contaminated with *P. aeruginosa* was implicated in the transmission of organisms; removal of this hand lotion ended the outbreak. Contaminated hand lotion applied to the clean hands of health care workers may have lead to direct inoculation of infants at high risk of infection.

Quality of health professionals' hand hygiene

Hands have been shown to be important vectors for hospital-acquired infection. Accepting the high risks of transmission of potentially pathogenic bacteria from hands of health care workers it is important to consider the frequency and techniques used by health professionals for handwashing. Taylor (1978a;1978b) showed that techniques used by nurses for handwashing were of short duration and inadequate. Albert and Condie (1981) recorded whether doctors, nurses and other health personnel washed after direct contact with either patients or medical support equipment in medical

intensive care units. Covert observations were made during 10 four-hour busy periods including all patients and all patient contacts. Forty doctors and 15 nurses had contact with 28 patients, handwashing occurred after only 41% of contacts with doctor handwashing less often than nurses. Larson *et al.* (1986) studied handwashing practices of 22 personnel in an oncology unit in an urban medical centre for 2 months. During 891 person-hours of observation, 986 hand washes were observed. Subjects washed a mean of 1.1 times an hour for a mean of 13.2 seconds. A total of 558 isolates were recovered from 158 hand cultures. Doctors handwashed less often than nurses, but washed for longer and used better techniques than the nurses did. *Coagulase negative staphylococci* isolated from hands of physicians and nurses were significantly more resistant to antimicrobial agents than those of personnel with minimal patient contact. Larson *et al.* (1986) found that self-reporting of handwashing practices by personnel was inaccurate and handwashing practices vary significantly by professional group. Graham (1990) observed hand decontamination in an intensive care unit before and after the introduction of an antiseptic hand rub solution. The intensive care unit contained 18 beds. Staff were informed of an audit of infection control procedures, but not that handwashing practices were being specifically observed. Handwashing frequency and duration were observed in six observation periods during a two-week period. Each observation period was for three hours covering a busy time on the intensive care unit. After the initial two week observation period an antiseptic (alcoholic) hand rub was introduced. A total of 884 patient contacts and 341 hand decontamination episodes were observed. In stage I, before the new hand rub was introduced, handwashing occurred 32% of the time. In the second period hand decontamination occurred 45% of the time. Nurses who had the highest number of patient contacts were also least likely to wash their hands after patient contact. Observations showed that handwashing was below the recommended minimum period for handwashing of 10-15 seconds.

Albert and Condie (1981), Larson *et al.* (1986) and Graham (1990) all studied handwashing practices outside the UK, whilst Gould assessed nurses' hand decontamination performance in the UK (Gould 1993; Gould 1994; Gould *et al.* 1996). Gould (1996) emphasised the strength of evidence that hand decontamination is performed too seldom, and not always after activities likely to result in heavy contamination. She found hands were only decontaminated after 29% of all patient contacts, but this increased to 50% for activities likely to results in heavy contamination. Performance of hand decontamination was related to workload and the availability of hand decontamination equipment, especially when the nurses were busy.

Gould's results showed that although nurses are at high risk of acquiring infection, gloves were not always worn during contact with patients' secretions. A multi-disciplinary infection control audit in a 1,000 bed hospital found a lack of knowledge throughout an NHS Trust in the UK (Perry and Gore 1997). As a result, a more detailed study was undertaken to assess documentation, practices and knowledge of infection control. Researchers observed handwashing practices of 19 nurses on leaving an isolation cubicle. Fifteen observations were made over 10 hours and 15 minutes. They found compliance with handwashing was poor. Handwashing occurred in only nine cases and a totally correct procedure was only carried out twice. A similar study was carried out by Gallagher (1999). She visited nine wards to observe handwashing and gown use. Her results suggested that handwashing was a neglected area of practice. During her study Gallagher observed: doctors' failure to their wash hands before rounds and between patients; failure of staff to remove plastic aprons between patients; telephones being answered by staff whilst wearing gloves; a nurse wearing gloves and apron holding a patient's notes and drinking a glass of water, who proceeded to visit another unit wearing the same apron; a nurse wiping her nose with her fingers proceeding to dispense medicines without washing hands; a nurse changing a urinary catheter bag without wearing gloves; a nurse washed and dried a patient's feet proceeding to open a sterile pack without washing her hands; a nurse set up a heparin infusion without washing her hands; a nurse making a bed, and without washing her hands, cleaning a patient's teeth, handling a set of patient's notes and giving an injection and finally a student nurse answered a telephone while wearing blood stained gloves.

Sproat and Inglis (1994) conducted a detailed survey of hand hygiene in 16 intensive care units in Yorkshire. Seventy-four nurses observed and recorded 381 observations of visiting healthcare staff hand hygiene practices in eleven of the sixteen units (65%) during patient contact. Observed hand hygiene practice of all visiting healthcare professionals was inadequate, but hand hygiene by medical staff was less frequent than other healthcare professionals. The frequency of hand hygiene by more senior grades of medical staff was lower than by more junior staff. Hand hygiene was particularly low for radiographers; handwashing before (6%), handwashing after (9%). The group of healthcare workers who practised hand hygiene most frequently were physiotherapists, handwashing before patient contact (56%), after contact (75%) and glove wearing (39%). Some intensive care units in the region did not have any infection control policies and some were inadequate. Some unit policies did not require handwash after tracheal suction (19%), after wound care (12%) or after mouth care (19)% and some

policies did not require handwash before urinary catheter bag emptying (31%) nor the use of gloves (18%) during this procedure. One hundred and sixteen nurses from 9 (56%) intensive care units returned questionnaires that reflected nursing workload and hand hygiene practices. During the shift, ninety-five nurses (82%) were responsible for only one patient, however, of these 95 nurses, 82 (71%) had assisted with procedures on other patients. Nurses' hand hygiene practices were self-reported and results showed wide variations from recommended infection control precautions. Handwashing by nurses was more frequent after patient care than before. Nurse's self-reported compliance with recommended policy was particularly poor before; urinary catheter bag emptying (24%), mouth care (52%) and endo-tracheal suction (74%). Some nurses did not report any type of hand hygiene before intravascular device care (11%) or wound dressing (14%). Results revealed intensive care unit nurses' attitudes to infection control: some perceived intensive care and intensive care nursing as being of a specialist nature and expressed a need for more staff involvement in the local setting of standards for infection control, some nurses stated that a lack of effective communication was a problem, with some nurses wanting multidisciplinary involvement in the writing and review of infection control policies, some respondents expressed a need for more in-service education and greater contact with the Infection Control Team. Feedback on infection rates and infection control bulletins being made available were two suggestions made to improve infection control in the intensive care unit.

Changing handwashing practices

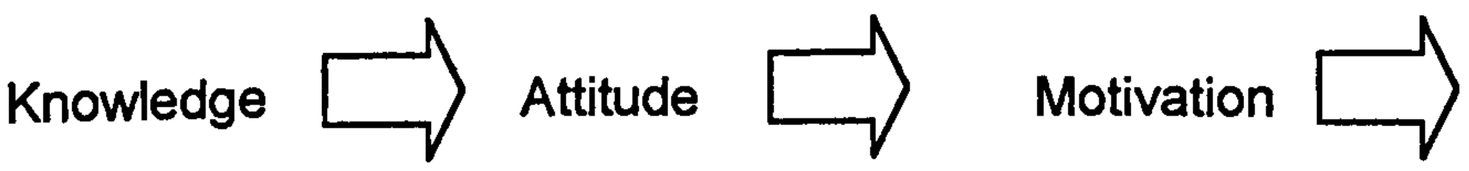
Conly *et al.* (1989) made observations of handwashing practices and measured the incidence of intensive care unit-acquired infection in a 16-bedded intensive care unit before and after each of two educational programmes separated by a time period of five years. Before the study started intensive care unit-acquired infection rates were 33% and this fell dramatically to 12% after the first educational programme. The handwashing rate after patient contact rose from 28% to 81%, but this improvement did not persist. During the subsequent five years, the infection rates rose to pre-study rates. A second educational programme improved handwashing from 23% to 60% and intensive care unit-acquired infection fell from 33% to 10%. Simmons *et al.* (1990) studied nurses' handwashing and endemic infection rates in two intensive care units. After six months (May to October 1983) of covert observation of handwashing, interventions were introduced in three stages. The first intervention - initiated in November 1983 - included staff questionnaires and education sessions. The second intervention began in January 1984 and included a promotional intervention (wearing of badges). The third intervention began in April 1984 with observation of practice with

feedback. Data collection and observation ceased in May 1984. For the purposes of the study, handwashing was considered necessary before IV care, before and after wound care, after touching a contaminated object and before performing an invasive procedure. Results showed handwashing was generally poor and there was no observed handwashing before IV care. Handwashing gradually improved over the four months of post-intervention monitoring, rates before intervention were 22% and afterwards were 30%, but this was not a significantly significant increase. Nurses when questioned thought they were appropriately handwashing 80-90% of the time. Researchers did not find any association between the improved handwashing and infection rates. They concluded that handwashing is difficult to change and suggested that handwashing was not closely related to cross-infection. This conclusion must be challenged. Observation and interventions did not include medical staff and the study only continued for one month after the observation feedback intervention. Nurses had rated the feedback intervention as the most important in encouraging handwashing. The authors acknowledged that if the study had been prolonged a major improvement in handwashing may have impacted in infection rates. A key finding in this research was that nurses did not perceive that they had a handwashing problem that needed solving.

Bartzokas (a Medical Microbiologist) and Slade (a Clinical Psychologist), introduced an infection control educational campaign which they researched and designed for clarity and maximum psychological impact (Bartzokas and Slade 1991). This was launched to impart up-to-date knowledge of infections and their control. Specific instructions were given concerning practical applications. The researchers chose *"hygienic hand disinfection"* as a marker to monitor change. Bartzokas and Slade found that although knowledge about the importance of handwashing was improved, the educational campaign was not followed by higher handwashing frequency and no lasting change in attitudes of staff towards infection control was noted. The authors believed correct knowledge is not always applied in practice. They found health professionals demonstrated a low perception of the importance of infection control measures and a general lack of motivation to comply with recommended practices. They argued that, although staff did have a theoretical awareness of the value of complying with recommended procedures, in practice this seems to have a low priority.

Bartzokas *et al.* (1995) followed up the their previous study and attempted to use a psychological approach to influencing hospital infection control in the UK. They argued that hospital infection control programmes have focused more on the technological and

engineering approaches than on influencing the behaviour of personnel. They proposed that the single most important influence on hospital-acquired infection is a change in attitudes and behaviour of doctors and nurses. They stressed the need for staff education and increasing staff compliance with infection control measures. Bartzokas *et al.* (1995) supported the view that education and specific training in infection control was necessary if policy recommendations were to be carried out and that provision of information is the most influential method for effective infection control. The authors believed this adhered to the theoretical principle of *"Reasoned Action"* (Ajzen and Fishbein 1980) which assumed that people do consider the implication of their actions before they engage in a given behaviour. Their review of the literature suggested that a concerted informational campaign could increase the compliance with basic infection control procedures. This was a controlled study conducted in two hospitals in England. One, the experimental hospital, was an 820 bedded General Hospital in Liverpool and the control was a London hospital of similar size and function. The researchers hypothesised variables which might influence infection control behaviour and used the *"Attitude-Behaviour Model"* to guided the various parts of the study. Their theoretical underpinning took the model of:



Bartzokas *et al.* (1995) used a wide-ranging interventions and researched attitudes, knowledge, and practices of healthcare professionals before and after their interventions. Results showed that both medical staff and nurses displayed a positive attitude to infection control and that they had a high level of knowledge about the causes and methods for the prevention of hospital-acquired infection. Staff thought *"shortage of time"* and *"forgetting"* were the most commonly reported reasons for staff not complying with infection control procedures. The educational and informational promotion was designed to impart knowledge of infections and their control as well as specific information concerning practical applications. The researchers were hoping to encourage transition from theoretical knowledge to correct hygienic practice. Educational interventions included: wall posters, A4-size book and A4 sized door notices. After three weeks, staff were surveyed for their usage and acceptability. Only a third of doctors and half of the nurses had seen the notices and information. However, all respondents who had referred to the information found it useful. The promotional campaign involved providing an optimal soap solution developed in response to staff preferences, handwashing posters, a training video on handwashing.

The research included a longitudinal study of handwashing frequency by clinical staff during routine patient care. They automatically monitored use of soap used for handwashing. Fifteen monitors were installed in a 25-bedded orthopaedic ward and 13 monitors were installed in a gynaecological clinic with a throughput of 60 patients per day. Nurses on the orthopaedic ward averaged 5.5 handwashes per nurse per shift and nurses in the gynaecological clinic averaged 7.3 per nurse per shift. Nurses' self-reported a handwashing frequency in the orthopaedic ward was 19.5 per shift and in the gynaecological clinic it was 24.8%, both self-reported frequencies being around three times greater than actual handwashes measured. When staff washed their hands the researchers found the technique was poor, 65% of nurses missed important areas of hand surfaces. The researchers found the handwashing of senior doctors to be very low, only two handwashes were made in 21 hours of observation. Neither the educational or promotional campaign succeeded in improving doctor's compliance. They found no changes in attitude to infection control, but knowledge of hospital-acquired infections and their control was significantly improved. These gains were lost at the time of follow-up, six months later. Results showed that handwashing frequency did not change as a consequence of the educational campaign, but increased following the promotional campaign. The authors believed that in judicious implementation of hygiene nothing counts more than thinking, *"micro-organisms, however being out of sight also remain out of mind".* Bartzokas *et al.* (1995) felt that the importance of personal responsibility had not been recognised,

> *"Clinical psychologists, when describing patients who do not follow doctors orders, refer to non-compliance. What term can one use for doctors, who by disregarding the fundamental tenets of hygiene, harm their patients? Is negligence too strong an epithet for such aberrant behaviour?"*

Tibballs (1996) introduced a comprehensive strategy to increase the frequency of handwashing by medical staff. He conducted a prospective study of handwashing before and after patient contact in a paediatric intensive care unit. Sixty-one medical staff were included in a five-phase behaviour modification program:

(i) unobtrusive observation for four weeks to obtain a baseline handwashing rate;

(ii) overt observation for five weeks (preceded by written advice);

(iii) overt observation continued for four weeks with performance feedback;

(iv) all observation and feedback discontinued for seven weeks; and

(v) unobtrusive observation for five weeks to obtain a residual rate.

Nine hundred and thirty-nine patient contacts were observed. The baseline handwashing rates before and after patient contact were 12.4% and 10.6%, respectively. During overt observation, the respective rates increased and plateaued at 32.7% and 33.3%, but increased further (to 68.3% and 64.8%) during the period of performance feedback. Residual handwashing rates, observed unobtrusively seven weeks after the cessation of performance feedback, were 54.6% before and 54.9% after patient contact.

2.9 Knowledge of Infection Control

Research indicates that fewer than half of patient contacts are preceded or followed by handwashing and this poor practice of a basic infection control practice appears to be unchanging over the last decade (Larson 1989). Taylor (1978b) after studying handwashing concluded that the nurses involved appeared to have their own concepts of how cross-infection occurred. Her observations suggested that nurses seemed to believe that if their hands were not physically soiled, then no infection could be spread.

Horton (1992) argued that quality assurance and effective infection control were inseparable. She explored the value placed upon, and the general awareness of, infection control by nurses and nurse tutors. Horton cited Meers who referred to hospital-acquired infection (Meers *et al.* 1981) as a *"silent epidemic"*, which they claimed was ignored by both nurses and doctors. Horton contested this opinion, she believed that to ignore a situation implies prior knowledge and awareness which in her experience *"did not exist"*. Horton had found that nurses entering her link control liaison nurse scheme showed a level of ignorance of hospital-acquired infections and the factors involved in prevention. She found nurses had a vague memory of being taught microbiology and *"thinking infection control"* had only rarely been considered an integral part of patient care. Horton believed that, without this awareness, *"infections could be considered a natural part of [...] patient outcome"*. Her primary research question was, *"are nurses prepared to be safe infection control practitioners?"* Results showed that nurses relied on the knowledge gained through their pre-registration training. Some tutors described their knowledge of applied microbiology as *"poor"*, and the majority of nurses described it as *"fair"* or *"poor"*. Horton continued her research by examining infection control in education and practice in more detail (Horton 1993). She received responses from 71 nurse tutors, 54 student teachers and 63 qualified nurses.

Her results suggested that although microbiological knowledge is considered necessary for safe infection control practice, nurses' actual knowledge was inadequate. Nurse tutors thought the level of knowledge taught was adequate and that nurses' knowledge was topped up in clinical practice. Horton concluded that nurses and teachers did consider knowledge of microbiology was essential for safe infection control practice, but the level of knowledge provided was insufficient.

Gould and Ream (1994) interviewed 173 nurses in two hospitals and explored their views concerning infection risks to themselves and patients. They wanted to identify any problems that nurses perceived in safely performing infection control precautions during routine activities. Results suggested that although nurses were interested and concerned about infection control, no data could be collected relating to pre-registration education because most nurses had forgotten any details. In regard to post-registration, nurse perceived their needs as being unmet. The nurses involved in the study perceived difficulties in providing safe infection control related to lack of resources and lack of expert guidance.

Macqueen (1995), an Infection Control Nurse, worked as a health care assistant on a 10-bedded paediatric medical intensive care unit. She conducted an anthropological study observing *"ritualistic practice"* of infection control using participant observation. She found that hands tended to be washed less thoroughly and less often after dirty tasks. However, she observed exaggerated rituals before and during aseptic procedures. Macqueen found that many of the measures taken to restrict the transmission of infection involved ritualistic theatrical behaviour patterns that bore no relevance to effective infection transmission. She believed preventative care was abused by professionals and seen as unimportant. Staff explanations as to why infection occurred were inadequate and they tended to blame other people.

Courtenay (1998) discussed nurses' compliance to approved infection control practices, and the need for nurse educators to provide learners with up-to-date information for practice. She emphasised the paucity of nursing literature critically exploring the role of learning theories in relation to actual nurse learning. Courtenay (1998) aimed to determine the theoretical principles of infection control and the related practices that were taught to qualified nurses, students and health care assistants.

She used focused ethnography to explore the infection control *"knowledge"* taught on nursing education programmes: an RGN programme, a Project 2000 course, a BSc in Nursing and a health care assistant programme. She chose two mixed male and female wards to explore nurses' and health care assistants' understanding of infection spread. Seventeen ward staff - a sister, a charge nurse, six staff nurses, three Project 2000 student nurses, three third year RGN students and three health care assistants - were included in the sample. Courtenay's aim was to understand how knowledge was applied in practice. Research methods included observation of lectures, interviews with nurse lecturers and collection of documentary evidence. On the wards Courtenay acted as participant observer, using video recordings, interviews and collection of documentary evidence. Courtenay found that educational content was minimal, lacked consistency and was not applied in practice. Nurses and health care assistants had their own *"alternative frameworks"* concerning the motility, spread and survival of micro-organisms.

2.10 Learning infection control

Akinsanya (1985) explored why nurses have difficulty learning the biological sciences underpinning nursing practice. He showed that biological sciences caused anxiety for learners at all stages of their training, for nurse tutor students and for course directors of nurse tutor courses. He believed the relationship between the theoretical underpinning of nursing actions and the realities of practical application of this knowledge in practice remained a major source of anxiety.

> *" [...] the application of natural and life sciences to nursing practice is largely derived from medical science and that attempts by nurses to establish a direct knowledge base in life sciences are thwarted because, by and large, their information is not only derived second-hand from medicine, but there are few nurses with academic training in these subjects and they have made little impact on the direction of nurse training."*
>
> Akinsanya (1985)

Courtenay (1991) conducted a study of the teaching and learning of biological sciences in nurse education. She found that students perceived the balance between the behavioural and biological sciences was too much in favour of the behavioural sciences and the level of biological sciences being taught was inappropriate for registered nurse training. Teachers felt inadequately prepared to teach the biological sciences and self-directed methods of teaching and learning, although used most frequently, were perceived by students as being the most ineffective.

2.11 Theory-practice gap

Effective prevention of the spread of infection is a fundamental component of all nursing care activities and yet nurse researchers have drawn attention to the nurse's inability to apply research-based theoretical knowledge, gained largely in the classroom, to the bedside (Akinsanya 1985; Mulhall 1990; Courtenay 1991). Akinsanya (1985) referenced his earlier work that identified concern from learners at all stages of their training and suggested that *"the knowledge input remains sterile"*. Akinsanya (1985) found that, although there is a general agreement on the importance of life sciences to the nurse demonstrating professional competence, the role of life sciences in professional development was less clear. In his view this theory-practice gap remains largely implicit to all areas of nurse training, at the cost of professional competence and patient care. Akinsanya (1985) recommended an examination of the contributions of life sciences to nurse education. In his view, this would provide a concentrating and illuminating exercise, facilitating identification of a unique body of knowledge of direct relevance to nursing practice.

Mulhall (1990) believed that nursing practice research has a vital role to play in determining the effective prevention of hospital-acquired infection. In her view scientific knowledge necessary to formulate rational nursing practice was lacking. She believed that *"skills and knowledge are necessary to determine efficient and effective nursing practice are of a high level"*. She referred to surveys of practice, where practice is at variance with research based recommendations and raised some fundamental questions regarding the content and communication of infection control policies. Mulhall called for an integration of research and practice. She believed *"it is crucial that questions addressed by nursing practice research are derived from practice"*. Mulhall argued that although nursing is perceived around principles that require an understanding the concepts of health, illness, disease, infirmity and disability, there have been difficulties in identifying and defining the knowledge fundamental to the caring function of the nurse. She believed both fundamental knowledge and applied research were necessary to advance the scientific basis of clinical care. Mulhall suggested that to successfully utilise knowledge, the cognitive skills demanded during nursing required more critical exploration in order that knowledge can be presented in the best format for uptake by practitioners.

2.12 Teaching infection control

Akinsanya (1985) conducted research into teaching of infection control. In his research, of 324 nurse tutors questioned, only 30% felt adequately prepared to teach life sciences. The main areas of concern for nurses in teaching life sciences were:

- difficulty in simplifying biological facts when teaching learners
- shortage of appropriate books and other teaching material.
- use of a medical model.
- responsibility for teaching life sciences was shared with medics
- absence of any distinctive nursing approach to learning and teaching

Courtenay (1991) discussed the higher educational entry level of nursing students, but found that less than a quarter of teachers held diplomas or degrees. She felt that, *"with regard to content of knowledge, it would seem that knowledge from the biological sciences is taught in an haphazard and unstructured way."* She concluded that there needs to be clearer guidelines as to the depth and breadth of knowledge to be taught from the biological sciences.

Tmobranski (1993) discussed how in recent years there has been considerable emphasis on the social and behavioural sciences in the nursing curriculum with a corresponding tendency to devalue biological sciences. Tmobranski (1996) explored the status of biological sciences in the nursing curriculum. She found that some teachers reported a lack of coherent structure with regard to biological sciences and her results indicated that students had difficulty recalling basic biological concepts. Tmobranski thought students had difficulty in understanding the basic biological principles because this knowledge was not perceived as relevant to nursing practice. She argued for the biological sciences as essential for the development of *"intelligent practitioners"* and the progress of nursing. Tmobranski believed that without this knowledge, nurses are unable to deliver safe, high quality care. She calls for an urgent review of how the biological sciences, in regard to nursing practice, are structured and taught in the classroom.

Nurses frequently claim their practice is holistic (Clarke 1995), but Clarke also supported the view that there has been considerable devaluing of the acquisition of use of biological science knowledge within the nursing profession in the UK. She questioned, *"how can nurses claim to be holistic if the biological basis of health and illness and the biological component of nursing interventions are ignored?"* In Clarke's opinion, the emphasis on knowledge from the social sciences in nursing is welcomed, but claims that holism can

only be achieved if all areas of relevant knowledge are acquired and used in a balanced way. Wynne *et al.* (1997) believed that the fundamental question raised by this debate is,

> *"how best can teachers impart biological knowledge in a way that can be readily applied by students and qualified nurses to inform their practice?"*

2.13 Integrating theory into practice

Unless research-based evidence and guidance is incorporated in practice, efforts to improve the quality of care will be wasted (NHS Centre for Reviews and Dissemination 1999). For evidence based practice to occur, clinicians require to have information about best practice, including being able to access information about research, research development and dissemination, and to put knowledge into practice and evaluate the effect on patients.

Coyle and Sokop (1990) examined adoption of research by clinical nurses and explored the characteristics of nurses that may have influenced their use of innovations. Three of the fourteen research-based nursing practices examined were related to infection control. They were the care of invasive medical devices, the removal of intravenous cannulae after 48 hours and the maintenance of closed sterile systems for urinary drainage. Of 113 nurses questioned ninety-one percent were aware of the recommendations for intra-venous cannula removal, but only forty percent complied with this all the time. Ninety-four percent of the nurses were aware of the recommendations for closed sterile system of urinary drainage, only six percent complied with the recommendations all the time. The majority of nurses had leamed of the practices through the professional literature, by attending conferences and in-service training. This suggested that the nurses were sensitive to both institutional communications and the opinions of other professionals. The nurses' perception that a hospital policy existed for a particular practice was significantly related to their level of persuasion about and subsequent use of research findings. Coyle and Sokop (1990) suggested that innovative practice is more likely to occur when there has been formal recognition or authority for its usefulness. They suggested that nurse managers and administrators should examine these findings and involve nurses in clinical research and educational programmes in order to increase research-based nursing practice.

Thomas (1985) found that although many nurses had a positive attitude to research, they were unaware of research findings and did not know how to implement them. Hunt (1987) put forward five reasons why nurses do not use research findings:

- they do not know about them
- they do not understand them
- they do not believe them
- they do not know how to apply them or,
- they are not allowed to use them

2.14 Resistance to change

Staff demonstrate resistance to infection control educational programmes (Conly *et al.* 1989; Simmons *et al.* 1990) and although these programmes can be successful in the short term, the benefits of educational programmes are short-lived if they do not become a permanent component of continuous education. Infection control depends upon a variety of skills to assist in the prevention of hospital-acquired infection in healthcare facilities (Campbell 1991). Campbell felt that this strongly suggested that the present body of knowledge and skills associated with infection control would not ensure that personnel do what needs to be done in order to prevent hospital-acquired infections. She suggested that a knowledge of the two important concepts within organisations, power and motivation, may enhance an ability to promote better infection control.

2.15 Effective infection control

Studies have demonstrated that proactive intervention can break the chain of events leading to hospital-acquired infection. Whilst a proportion of infections are unavoidable, due to patient and environmental risk factors, there is potential to reduce infection rates by improving clinical practice (Meers *et al.* 1981; Currie and Maynard 1989; Department of Health 1995). The majority of research in prevention and management of hospital-acquired infection has been conducted in American hospitals.

The SENIC study

Eickhoff (1980) described how the American Study of the Effectiveness of Nosocomial Infection Control, the SENIC study, was

> *"born in 1974 out of uncertainty, concern and frustration felt by infection control workers, who wondered if all the things they were doing and saying were making any difference".*

The situation was one of not being able to define what was important to infection control, or to demonstrate if infection control worked at all. The methods for funding the health system in the USA meant that costs of infection control nurses and surveillance activities could not be charged directly to patients or to third-party carriers as would be in the case of other technologies. Haley *et al.* (1985) were concerned that increasing fiscal pressures on hospitals, would mean that preventative infection control programmes would probably receive lower priority in their operating budgets. They emphasised that effective infection surveillance and control programmes would only have to reduce infections by 6% for the costs to be offset by savings from reduced hospitalisation.

The SENIC study was conducted from 1976 to 1978 by the Public Health Services's Centre for Disease Control (CDC). Eickhoff (1980) described the SENIC project as *"a truly massive undertaking"*, made necessary by the investigator's concern with statistical power and sample size. In practical terms the research tested whether routine surveillance of hospital-acquired infection that the CDC had been recommending during the early 1970s were actually effective. The original charge was to evaluate the effectiveness of infection surveillance programmes only, however, after developing conceptual models of the activities included in infection control programmes, the SENIC planners framed the hypotheses of the study in terms of two mathematical indices: infection surveillance and infection control (Haley *et al.* 1981). Infection surveillance activities were described as: collecting, analysing, disseminating and using data to prevent and control hospital-acquired infections. Infection control activities were described as: formulating policies, training personnel, manipulating the hospital environment and other ways, not directly related to surveillance activities, to prevent and control hospital infections. The SENIC researchers chose to represent the main activities with indices because of the *"complexity and diversity"* of each of the two approaches, allowing measurement of the intensity of the hospital infection surveillance and control programmes (ISCPs). The SENIC hypothesis predicted which ISCP activities would be effective, *"the measurements of the "dose" for our "dose-response" analysis"* (Haley *et al.* 1985). The study was planned between 1974 and 1976, and data were collected in a representative sample of hospitals in three phases between 1976 and 1978. Phase I involved preliminary hospital screening questionnaires; phase II was the hospital interview survey and phase III was the retrospective medical record survey. The SENIC target population was all general (short-term) medical and surgical hospitals with at least 50 beds which were not Federal or State owned within the USA (Haley *et al.* 1985).

SENIC study: phase I

Preliminary screening questionnaires were distributed to all hospitals in the USA. The response rate was 86%. Surveillance questions required information on frequency and methods used to identify new cases of hospital-acquired infection, the techniques used to tabulate the data and the means of reporting the results to physicians and nurses delivering care. Responses were analysed in three stages to calculate a quantitative index for both infection surveillance and infection control for each hospital,

1. unadjusted index calculated by taking a weighted sum of the responses
2. index adjusted by time spent on activities and qualifications of the staff
3. final ISCP intensity was defined as: low, mid-low, mid-high, and high

Hospitals were stratified by the four categories of the two indices (surveillance index and control index) yielding 16 design strata from all hospitals.

SENIC study: phase II

Phase II was the Hospital Interview Survey. All hospitals were sub-categorised by hospital size and medical school affiliation. Four hundred and thirty-three hospitals were randomly chosen for extensive on-site interviews. In each site twelve members of staff, with duties related to infection surveillance and control, were interviewed by CDC researchers. In addition a random sample of staff nurses were interviewed by a written questionnaire administered in group sessions. Responses in Phase II were used to corroborate and supplement responses obtained in the Preliminary Screening Questionnaire (Phase I).

SENIC study: phase III

Phase III was the retrospective chart review (RCR) to determine hospital-acquired infection rates. SENIC pilot studies had determined the sensitivity and specificity of the RCR technique to be 0.74 and 0.96. The SENIC study measured overall infection rates and the rates for the four site-specific infections: hospital-acquired pneumonia, bacteraemia, surgical wound infections and urinary tract infections. From each of the 338 hospitals randomly selected from the 16 strata, 500 adult general surgical and medical admissions were randomly selected from each of the two research time periods. Time one (T_1) year was defined as the calendar year 1970 and time two (T_2) year as the 12-month period from April 1st, 1975 to March 31st, 1976. The total number of patients included in the study was 169,526 (Haley *et al.* 1981).

The *"infection percentage"* was the estimator of the infection rate. The dependent variable, or outcome measure for assessing the efficacy of the ISCPs, was the relative change of the infection rate. That was the degree to which infection rate increased or decreased from T_1 to T_2 relative to its magnitude at T_1:

$$\text{Relative change} = \frac{P_2 - P_1}{P_1}$$

where P_1 and P_2 were the infection rates at T_1 and T_2. Multiplying the relative change by 100 gave the percentage change of the infection rate from T_1 to T_2. Data analysis tested the association of ISCPs with the relative change in the rate of hospital-acquired infection. The calculation was standardised for covariables and confounding variables for each of the 16 design strata formed by the infection surveillance and infection indices. The three main confounding variables identified were: patient risk factors, characteristics of the hospital and completeness of the medical records. The researchers were confident that the standardisation process had ruled out the effects of these factors. The authors established that intensive infection surveillance and control programmes were strongly associated with reductions in rates of hospital-acquired pneumonia, bacteraemia, surgical wound infections, and urinary tract infections between 1970 and 1976 (Haley *et al.* 1985). Essential components of effective programmes were shown to be: conducting organised surveillance and control activities; having a trained, effective infection control physician; having one infection control nurse per 250 beds and a system for reporting infection rates to practicing surgeons. The authors found the strength of effectiveness of having at least one infection control nurse per 250 beds was progressively lost as the number of beds increased above this cut-off point. Programmes with very high intensity ISCPs reduced their hospital's infection rates by 32%. However since relatively few hospitals had very effective programmes, only 6% of infections were actually prevented. Despite the scale of the project and the strong evidence of the effectiveness of ISCPs, the SENIC study was not able to determine precisely which methods and schedules should be used in performing surveillance (Haley *et al.* 1985). Hospitals without effective programmes had an increase in overall infection rate of 18% from 1970 to 1976. This increase was thought to reflect the increased use of invasive devices and health technologies.

Psycho-social influence of the SENIC approach

Previous approaches to infection control had emphasised *"medical remedies or changes in the physical environment"*, however Raven and Haley (1982) believed it was more valuable to examine why some hospitals were more effective than others in influencing staff members to comply with infection control policies. An important requisite to studying the ISCPs in the SENIC study was to define the characteristics, likely causal pathways and measurement parameters of such programmes. Raven and Haley (1980) pointed out that *"this proved no simple matter, even to the CDC epidemiologists who have been involved in nosocomial research for a number of years"*. Having outlined the fundamental scientific problems to be examined the SENIC planners developed these conceptual models and several alternative study designs. They convened a multidisciplinary team to develop a consensus for a quasi-experimental approach to the study design. The SENIC project team enlisted a team of social scientists to contribute to the research. In 1975 the SENIC research team visited 20 hospitals to observe the variety of approaches to infection control and to interview staff. Field notes were compared with the hypotheses of the research team. Based on these experiences a comprehensive list of several thousand ISCP components and characteristics that appeared to be important and seemed to vary between hospitals. The items included were keyed to the conceptual models and four criteria were used to reduce the *"mammoth list to a still large but manageable one"*. An item was included if it measured an activity that was:

- likely to be effective
- commonly used in hospitals
- expensive or
- recommended by an official body

The final list included some 500 discreet topics that were used in questionnaires, resulting in more than 2,500 individual response items per hospital (Raven and Haley 1980). Twelve respondents were chosen from each hospital, including infection control practitioners, medical epidemiologists, nurses involved in direct patient care and other staff who were involved in ISCPs. In the survey responses were obtained from 13,000 hospital personnel in 433 hospitals, including 347 infection control nurses and 7,200 staff nurses. The study produced an *"immense"* amount of sociological data which were discussed in three book chapters, *'Hospital-acquired Infections as a Problem in Medical Social'* (Raven and Haley 1980), *'Social Science Perspectives in Hospital Infection Control'* (Raven *et al.* 1981) and *'Social Influence and Compliance of Hospital*

Nurses with Infection Control Policies' (Raven and Haley 1982). A broad range of information was obtained regarding the social influence of the ISCP staff. Raven and Haley (1982) focused their discussion on the social influence which seemed to have the greatest impact on staff nurses, particularly in their interaction with the infection control nurse. Important relationships were identified as significant at the 0.001 level of confidence. Extensive discussions of results were presented (Raven and Haley 1981) and found the following factors as significant influencing factors of the infection control nurses (ICNs) on staff nurses' infection control compliance,

- the availability and visibility of the ICNs
- the ICNs perception of herself and infection control
- the effects of ICN status on staff compliance with infection control policy
- readiness of ICN to take action with violators of infection control policy
- the perceived power of the ICN to influence others
- power bases utilised by ICNs

Raven and Haley (1981) described social influence of the ICNs on other healthcare professionals as *"social power".* This was the ICN's ability to change cognitions, attitudes or behaviour of a person (the target) which is attributable to the actions of the ICN (the influencing agent). The social power of the agent over the target was presented in six bases of power used by infection control nurses for changing behaviour of a nurse who *"repeatedly breaks technique and exposes patients to a high risk of infection"*

- *Informational power* – use of persuasive information by the ICN
- *Expert power* – target attributing superior knowledge or ability to the ICN
- *Referent power* – ICN's use of others as evaluating target behaviour
- *Coercive power* – the ability of the ICN to punish the target
- *Reward power* – the ability of the ICN to mediate rewards for the target
- *Legitimate power* – target acceptance of the role relationship

The infection control nurses were asked to rate each power base in terms of how likely they would be to use it and how effective they felt it would be. They were then asked to pick one power basis that they were most likely to use and the one that they considered most effective. Eighteen per cent of infection control nurses felt that coercive power was the most effective with staff nurses, whilst only 6% rated it as most

likely to be used. Infection control nurses reported using informational power – giving the target the reason for compliance and they also considered information power as most effective. Infection control nurses did not rate expert power very highly, but staff nurses were especially likely to attribute their compliance to the expertise of the infection control nurse. The SENIC researchers found that when coercive and legitimate power were selected by infection control nurses, use correlated with a general feeling of their own insecurity and inefficiency, while use of informational power correlated with their being a more positive ICN self-evaluation (Raven and Haley 1982).

Other SENIC style studies

A study conducted in a 1400-bedded teaching hospital in Hong Kong achieved a 30% reduction in hospital-acquired infection rate, from 9.9% to 6.0%, over three years (French *et al.* 1989; French and Cheng 1991). Prevalence studies of hospital-acquired infection were carried out every six months for three years. This was combined with introduction of a hospital policy for infection control and an increase of Infection Control Nurses from one to three. Using non-infected case controls, infected patients had an excess mortality of 7.4%, excess hospital stay of 23 days and increased antibiotic use. Results showed the programme had reduced the mortality rate, the length of patient stay in hospital and antibiotic use. The costs of the programme were 1.25% of the savings made available to the health service as a result of reducing the rate of hospital-acquired infection.

Seto *et al.* (1989) explored the role of communication in changing healthcare practice in a large hospital in Hong Kong. Seto and his colleagues wanted to investigate the discontinuation of nurses re-capping needles after use. They randomly selected nine wards and divided them into three groups of three wards, groups A, B and C. Responses from an initial survey divided nurses into those who agreed with discontinuation (the agreeables) and those who did not (the non-agreeables). Methods used to introduce the policy were a simple announcement through the nursing hierarchy in group A, a passive method (posters and pamphlets) was added for group B and both passive and active methods (in-service lectures) were used in group C. Five weeks later behavioural change was assessed by a self-report survey and by an unannounced direct needle count. Only 21% of nurses changed their practice by simple announcement. For the *"agreeables"*, 85% changed their practice by the passive methods and no further improvement was observed when the active method was added. However, 83% of the *"non-agreeables"* changed their practice when the active method was used while the passive method alone changed only 21%. Six months later a third survey indicated that

when the active method was included the change persisted at over 85%, whilst a 36% change was noted for the *"agreeables"* who were only exposed to the passive method. Seto *et al.* (1989) believed that implementation of policies is most effective in hospitals when an active method of communication is included, but if the staff are already in agreement with the change, a passive method alone will probably suffice. The change in practice associated with a passive method may not last and for long-term benefits, an active method should be included.

Seto et al. developed their research programme (Set *et al.* 1990a;1990b) and evaluated staff compliance with *"influencing-tactics"* in relation to infection control policy implementation in 20 Hong Kong hospitals. In phase 1, 45 infection control nurses were surveyed on the frequency of use of possible tactics. Twenty-three of the more frequently used influencing tactics were selected in phase 2 in which a random sample of 881 nurses were questioned on whether they would willingly or reluctantly or not comply with these influencing tactics. Based on a factor analysis the researchers found six dimensions of compliance were identified. These were, in order of effectiveness in achieving compliance,

1. professional-resources - providing specialised or expert help
2. professional respect - esteeming others as fellow professionals
3. coalition - obtaining staff support
4. ingratiation - cultivating goodwill
5. hierarchical - exerting pressure derived from rank and
6. non-communicative - ignoring or disregarding other's point of view.

Seto *et al.* (1990b) found their results correlated with the SENIC results on the use of social power in infection control. They viewed *"professional-resources"* tactics as correlating with the concepts of information and expert power. Seto *et al.* (1990b) believed that to achieve change in infection control practice required the contribution of the behavioural sciences. He proposed the basic concepts from each field can be applied to the work of infection control: the use of social power and the reasoned action model from the school of social psychology, the use of participatory decision-making from organisational behaviour and the use of opinion leaders from consumer behaviour.

2.16 The UK studies

The first National Prevalence Survey of infection in acute hospitals in England and Wales was conducted in 1980 (Meers *et al.* 1981). Of 18,163 patients studied in 43 hospitals 9.2% had a hospital-acquired infection (Meers *et al.* 1981). The second prevalence study was conducted in 1993 on a much larger scale than the first (Thompson and Smyth 1996). One hundred and fifty-seven hospitals throughout the UK and Republic of Ireland (Emmerson *et al.* 1996) and 37,111 patients were surveyed. A mean hospital-acquired infection prevalence rate of 9.0% was calculated with a range from 2% to 29%. Rates were higher for teaching hospitals (11.2%) than for non-teaching hospitals (8.4%). Four site-specific infections accounted for 66.5% of the total infections measured: urinary tract infection (23.2%), surgical wound infections (10.7%), lower respiratory tract infection (22.9%) and skin infections (9.6%). In 1980 there had been 18 cases of bacteraemia documented, accounting for 0.1% of the total prevalence of hospital-acquired infection. In 1993 235 cases of bacteraemia were documented, accounting for 0.63% of the total. Questionnaires to Infection Control Nurses who were involved in the data collection gave their overall impression of the survey. Results indicated that participation in the survey was stressful and time-consuming. Many infection control nurses commented on the time taken to complete the survey which ranged from 113 to 245 hours – with a mean time of 75 hours, giving an average time per bed of 13.3 min. All infection control nurses received help in performing the survey and only 10% were able to provide prior training to ward staff before the survey visit. Twenty-six percent indicated that they would not be willing to undertake a future survey. However, in one hospital the use of infection control link nurses with adequate preparation resulted in a survey time of only of 5.5 minutes per patient. Thompson and Smyth (1996) suggested that the longer times taken in other hospitals may have been due to increased times seeking information at ward level and recommended greater involvement of clinical staff at ward level, *"as they can answer questions more readily in relation to their patient's care".*

Incidence studies of infection in UK hospitals, although limited, have been consistent in reporting an incidence of about 5%. Raine (1991) published the only longitudinal study which has been conducted in the UK and measured incidence of hospital-acquired infection in three district general hospitals from 1978 to 1988. Over this period surveillance data were made available to medical and nursing staff and sent to the senior management team in the hospital. Results showed a 49% reduction in the incidence of hospital-acquired infection from 7.6% to 3.9% over 10 years. Glenister *et al.* (1992) investigated infection in patients occupying 122 beds in a district general hospital

between March 1988 and January 1989. Of 3,326 patients, 10 per cent (10.16%) had community-acquired infections and 10 per cent (9.92%) had infections acquired after admission to hospital. Incidence of hospital-acquired infection incidence by speciality ranged from 7.2% to 13.6% (Glenister *et al.* 1992). Ayliffe and Mitchell (1993) reported their results of an incidence study carried out in the 1970s. It was undertaken over two years to evaluate hospital-acquired incidence in a 900-bedded hospital. The overall rate was 5.6%, rates by speciality were; paediatrics 0.9%, obstetrics 1.9%, orthopaedics 4.5% and neonatal services 8.3%. Ayliffe and Mitchell (1993) remarked that the study took up all of the time of a Research Nurse and concluded,

> *"obviously research into optimal surveillance methods will continue, but the value and work involved in producing incidence rates, rather than selective surveillance of targeted areas, in reducing incidence of infection, remain unproven."*
>
> Ayliffe and Mitchell (1993)

Glenister *et al.* (1992) conducted a study of surveillance methods for detecting hospital infection. After considering the proportion of patients with hospital-acquired infection detected and the time needed for the data collection, laboratory-based ward liaison surveillance was judged to be the most effective method. This recommended method took 3.0 - 6.8 hours per 100 beds per week to collect data, plus time to collect denominator data and perform data analysis. Glenister *et al.* (1992) drew attention to the low ratio of infection control nurses to patients in the UK at the time. They concluded that with existing resources, it would be impossible to produce hospital-wide rates for all types of infection. They recommended that health service managers should consider whether further resources were required, and whether surveillance should be targeted to meet certain objectives (Glenister *et al.* 1992).

Results of UK studies have highlighted the difficulties in routinely measuring hospital-acquired infection within available resources (Glenister *et al.* 1992). However, it is *"notoriously difficult to manage what cannot be measured"* (House of Lords Science and Technology Committee 1998). The recently completed Public Health Laboratory Service (PHLS) audit of infection control activity in 19 district general hospitals (Glynn *et al.* 1997) recommended that surveillance systems used by infection control teams in the UK should now be extended to targeted surveillance of endemic infections, without impairing detection of outbreaks. The on-going UK programme of research is limited by methodological difficulties (Glynn *et al.* 1997; Plowman *et al.* 1997; Crowe and Cooke 1998).

Debate on methodological issues continues in the UK without national consensus on definitions for infections (Crowe and Cooke 1998), no recommended methods for surveillance and a lack of comparable data. A gap exists between immediate clinical needs and the production of useful information. Delays in developing integrated hospital information systems leads to an inability to provide any local measurements of endemic hospital-acquired infection.

The UK Nosocomial National Surveillance Scheme (NINSS) has been established by the PHLS with the objective of developing surveillance of nosocomial infection for routine use in the health service (Crowe and Cooke 1998). This voluntary scheme currently involves surveillance of wound infections and bacteraemias in 150 acute hospitals in England. Training is provided by the PHLS for infection control staff, but resources for surveillance must come out of Trust budgets. It is intended that consistent, anonymised data will enable hospitals to compare their infection rates with others (House of Lords Science and Technology Committee 1998), but this does not guarantee that information will be disseminated to all clinical staff. Some Trusts may not wish to join due to a lack of local support and funding, but there may be hospitals that actively avoid joining the scheme because they suspect it may cause adverse publicity. The National Programme of Surveillance is currently being developed to very high professional standards (Crowe and Cooke 1998), but the time between production of comparable national data and dissemination of useful information which might impact on changes in infection control practice will be considerable. The lack of clinically relevant information on endemic hospital-acquired infection and its costs, fails clinical practitioners who, on recognising a problem, wish to effect change have no means to judge the effectiveness of that change. It also fails patients who now recognise that infection control (or even general hygiene and cleanliness of hospitals) falls short of a minimum acceptable standard.

2.17 Identifying priorities for change in infection control

The rising emergence of antibiotic-resistant bacteria, the evidence of sub-optimal knowledge and practice of infection control, combined with evidence of effective methods for control means are concerning. The value of effective infection control cannot be denied, yet in some cases practices are not evidence-based and in some cases there is an absence of infection control practice. The subject of applied microbiology is difficult to teach to nurses and difficult for nurses to learn. Self-directed learning methods, whilst popular, are not appropriate for teaching microbiology. Nurses often lack knowledge of microbiology, fail to apply theory underlying the basic principles of

preventing infections or, do not integrate current research findings in their clinical practice. The theory-practice gap must be recognised and nurses must be facilitated to integrate knowledge into clinical practice. Two major strategies for supporting the changes required in infection control are proposed: improving the use of routine clinical information and influencing change in healthcare professionals' personal clinical practice of infection control.

Measuring outcome and improving the use of information

Audits of infection control structures and processes are becoming more popular as a cost-effective means of infection control quality assurance in clinical areas (Ching and Seto 1990; French and Cheng 1991; Inglis *et al.* 1992a; Bonadonna and Johnson 1992; Millward *et al.* 1993; Askew 1993; Gaunt 1993; French 1993; Sproat and Inglis 1994). Results have been useful in identifying problem areas and priorities for education, in raising awareness to the problem and as a basis for setting standards and promoting quality improvements in infection control. The problem in only monitoring infection control structures or processes without reliable measurement of patient outcome means that the value of providing additional infection control services for proactive prevention of hospital-acquired infection cannot be effectively demonstrated.

Nursing structures, nursing support systems and patient classification systems contain discrepancies in both definitions and methods (McManus and Pearson 1993). McManus and Pearson felt this lack of systematic research causes uncertainty and renders comparisons untenable. They believe nursing is a complex art involving the provision of hundreds of different specific activities in an infinitely diverse combination to satisfy patient needs and highlight that current outcome measures for nursing interventions are scarce. Nursing structures and processes need to be related to outcomes (Bond and Thomas 1991). Within healthcare practice, the knowledge of links between process and outcome is generally weak (Bond and Thomas 1991). Bond and Thomas believed that there is no harm caused by a *"professionalising ideology"* urging quality assurance initiatives, but that the importance of outcome measurement is unquestionable. They considered the question of whether nursing makes a difference is not trivial, but it is necessary to ascertain those aspects of nursing by professionally qualified nurses that are of benefit to patients.

In understanding the potential for enhanced use of routine clinical information in relation to effective infection control in the UK we need to look at the evidence from the SENIC research. This demonstrated the advantages of maximising use of clinical

information about hospital-acquired infection outcome. When combined with good infection control systems, targeted surveillance of the most frequent, most costly and most harmful hospital-acquired infections appears to be potentially most effective in reducing rates.

One method to overcome the difficulties faced in surveillance of infection is to improve information within routine clinical documentation. Many professions and disciplines are involved in the care of patients, however, nursing care continues over the full twenty-four hours of the day and is involved with every aspect of the patient's care. In this position the nurse must co-ordinate the activities of the clinical team, communicate changes in infection control measures for individual patients and ensure changes in policy are incorporated into the routine of the unit and disseminated to all members of staff (Bowell 1990). Nursing models of care begin with assessment of the deficiencies in self-care and identify fundamental human needs (Smith 1981). Smith suggested that if nurses accept this ideology and model of nursing, it also follows that nurses should be taught to identify patient needs. They should be assisted in developing appropriate clinical, practical and psychosocial skills in which to meet these needs. Assessment of patient needs and risks of infection and the delivery of care to proactively reduce those risks are important aspects of the risk management approach, aimed at protecting patients, staff and visitors.

Risk management, clinical audit and demonstrating evidence of best practice in relation to infection control would seem to be an essential component of raising the quality of caring for patients. If managed effectively, it could improve information systems and potentially reduce the cost of health care. Assessment of the risks of infection to and from patients should consider the patient, the integrity of the patient's natural defence to infection and the environmental & organisational factors within the intensive care unit. Once the risks of infection have been assessed, the Nursing Process will provide a systematic approach to meeting the needs of the patient (Ashworth 1984; Bowell 1990; Ayliffe *et al.* 1990). The registered nurse must be accountable for decisions made and care given. This emphasises the importance of research in nursing and the nurse must be able to explain, not only what care is given, but also why it is given (Bowell 1990). The Nursing Process offers a framework for a problem-solving approach comprising the steps of assessment, planning, implementation and evaluation (Ashworth 1984; Caddow 1989; Bowell and Webster 1986; Bowell 1990; Bowell 1992; Ayliffe *et al.* 1990). Infection control practices need to be integrated into the nursing procedures of each hospital. The problems of infection control should be identified in each clinical area and included in the care plans for individual patients (Ayliffe *et al.* 1990).

Influencing change in infection control practice

There is convincing evidence that current systems for service delivery and organsiation for prevention of endemic hospital-acquire infection is unsatisfactory, but would healthcare professionals consciously deliver poor standards of infection control care? What are the restricting factors that cause this deficiency in care? Change in the NHS has been constant, but it appears despite a sound evidence base that little impact has been made in the field of hospital infection control. The risks facing patients and health professional are increasing and despite advances in technology, even basic standards of hygiene in hospitals cannot be guaranteed. Many investigators have recognised that despite the availability of clear guidelines and a solid knowledge base, health care professionals often choose to ignore or compromise recommended infection control practices such as handwashing, isolation precautions and aseptic technique (Larson 1986).

Considering the research evidence, where would any individual start to address such a multi-factorial problem such as hospital-acquired infection within limited resources? Understanding the processes and people involved in service delivery would be a good starting point. The NHS health system and healthcare professionals work within a different philosophical base than in other countries. Understanding change and change processes might be useful. Larson (1986) highlighted the feeling of helplessness or lack of control over change and quoted St. Paul, *"I do not understand my own actions. For I am so far from habitually doing what I want to do that I find myself doing the very thing I hate. I do not act as I desire to act"* (Romans 7:15-20). Larson analysed change and infection control from a philosophical perspective and emphasised the complexity of the problems, she believed that three factors were necessary for change to occur:

- there must be dissatisfaction with the current situation
- perception of alternatives to the current situation
- recognition of the ability and potential for change

Larson (1986) believed that people who do not comply with *"ideal"* infection control techniques are not necessarily unreasonable, but they do not perceive that enhancing their infection control practices is a logical and preferable alternative to what they are currently doing. They will not change, because it requires *"tremendous effort to do so".* Larson (1986) recommended that part of the task of change agents is to present evidence that an alternative to current practice has a good chance of making a difference.

Utilising theories of change

Action research has been used, not only as means for introducing change, but also for generating critical knowledge about how change can, or cannot, be achieved. Action research utilises Lewin's Theory of Change which holds that human behaviour is a function of an individual's psychological environment and is a part of a continuum with individual variations from the norm being a function of tensions between perceptions of self and of the environment. Action research is becoming increasingly popular among nurse researchers (Hart 1995). Hart described action research as offering a means of narrowing the gap between theory and practice, of promoting the development of the nurse as *'practitioner researcher'*, and of empowering nurses and users to bring about change in their lives and work (Hart 1995).

Lewin described action research as proceeding in a series of steps, beginning with a general idea of what the problem or research question might be and examining this in relation to the means available to resolve the issues (Hart 1995). This exploratory stage might include more fact-finding about the problem as part of the process of developing an overall plan of action. A decision might then be made to make the first action step, which in turn might involve modifying the original idea. The first action step is then evaluated, ideas & plans are further modified and the process repeated in a cycle of planning, action and fact-finding. Lewin's cycle of change includes four key stages: *"unfreezing"* - a period of coming to terms with the need for change; introducing new values; a period of accepting these new values and a period of consolidation. Use of action research implies more than an attempt to make technical changes to practice. Action research is seen to have the potential to bring about fundamental change in the attitudes and behaviour of practitioners. Nurses may be empowered to become autonomous practitioners, able to establish more egalitarian working relationships with doctors and users (Hart 1995).

Seto *et al.* (1990a;1990b) believed that to achieve change in infection control practice required the contribution of the behavioural sciences: social psychology, organisational and consumer behaviour. Harkavy (1987) discussed change in infection control. She recommended that health professionals must re-think their interrelationships and work together, *"we must strategise, plan, communicate and prove our value to the system"*, emphasing that competence relates to understanding and control of pertinent information.

Analysing the potential for change

Cluff (1971) pointed out that surveillance of hospital infections has four purposes: the methodological detection and recording of infections, determination of endemic rates of hospital-acquired infection, control of infection and education of hospital staff. In discussing surveillance as an infection control system, Cluff believed that intensive surveillance programmes resulted in changes in infection control practice and contributed to understanding and preventing of hospital infection (Cluff 1971). He emphasised that intensive surveillance cannot realistically be practiced in all hospitals, the main value of less intensive programmes was to stimulate action when problems arise and alert hospital staff to the general problems of hospital-acquired infection.

Haley et al. (1985) highlighted that earlier studies in the USA had dwelt too heavily on surveillance to the exclusion of active efforts to intervene in the hospital and to control the infection problems. They emphasised the results of the SENIC study supported the *"great importance"* of combining active control activities with surveillance programmes. He proposed a new approach, *"surveillance by objective"*. He defined outcome objectives as reducing hospital-acquired infections and process objectives as infection surveillance and control efforts, including patient care practices of doctors and nurses. Haley (1985) emphasised the main purpose of surveillance by objective was to establish a system for managing infection control to prevent the most infections with the resources available to the infection control staff.

Chapter Three

Infection control in the intensive care unit

Although the proportion of patients requiring intensive care is small, these patients account for the largest proportion of hospital-acquired infection, have the highest morbidity & mortality, and the highest cost to the health service. Incidence of infection acquired in intensive care units (ICUs) ranges from 25% to 35% with most outbreaks of infection and most blood stream & device related infection occurring in critical care units (Perl 1993).

3.1 The Intensive Care Unit

Intensive care units provide facilities which have resulted in major improvements in the chances of survival in some conditions that were previously considered life-threatening (King's Fund Panel 1989). Against a background of uncertainty of the cost-benefits of intensive care, the King's Fund convened a multidisciplinary panel to consider intensive care services in the UK. A definition of intensive care was agreed as *"a service for patients with potentially recoverable diseases who can benefit from more detailed observation and treatment than is generally available in the standard wards and departments".* The panel described an intensive care unit as a place and not a treatment. The intensive care unit provides special skills and experience from medical and nursing staff for the care of critically ill patients and particularly those in whom there is an expectation of failure of one or more organs. It also provides a centre for physiological measurements, nursing procedures and therapeutic manoeuvres which are not practical in the general wards (King's Fund Panel 1989). The panel highlighted the lack of cost-benefit data of intensive care in the UK and called for a substantial programme of research, including an urgent need to agree what data (clinical and economic) should be collected for proper audit of intensive care.

The King's Fund Panel commissioned a study by Shiell (1991) which explored the economics of intensive care in the UK. Shiell conducted a small exploratory study looking at costs in two intensive care units in 1987-88. Costs, excluding overheads, averaged £2000 and £2280 equivalent to £525 and £465 per patient day. Edbrooke *et al.* (1997) conducted a retrospective cost analysis of 68 patients admitted to a UK intensive care unit over a 10 week period. His results showed large variations in costs for individual patients, but average daily costs of intensive care treatment were £1152 including overheads.

3.2 Infection in the intensive care unit

The intensive care unit subjects highly susceptible patients to a variety of invasive procedures and those patients are concentrated in one unit (Daschner *et al.* 1982; Massanari and Hierholzer 1986; Benzer *et al.* 1987). Grouping critically ill patients together in the intensive care unit has advantages when organising their care. However, it also raises the risk of patients acquiring an infection. Patients admitted to the intensive care unit are much more likely to be colonised or infected with potential pathogens. Their care requires much more physical contact with healthcare professionals than on general wards and the patient is further exposed to the risks of cross-infection when admitted to the intensive care unit. Typical patients admitted to the intensive care unit are elderly, usually suffering actual or potential major organ failure and require multiple invasive medical devices and therapies. The intensive care unit is crowded with debilitated patients who are receiving broad spectrum antibiotics are being cared for by busy physicians, nurses and technicians. It is therefore an ideal environment for the emergence of antibiotic resistance (Flaherty and Weinstein 1996).

As modern medical technology advances, older and sicker people receive intensive care and health professionals are finding that successful treatment of the primary illness in the critically ill patient is hindered by infection (Hanson and Elston 1990). A prolonged stay in the intensive care unit as a result of infection exposes the patient to the risk of further complications and hospital-acquired infection may be a primary or contributory cause of death. Infection rates are three to four times higher for patients on intensive care than those on general wards with incidence of acquired infection in intensive care units ranging from around 13% to as much as 50% (Bihari 1992). Despite the increase in the array of therapies available for treatment of patients in intensive care, the treatment of infection acquired in ICUs has progressed very slowly (Rennie 1993). Rennie asked *"how can we decide to do about nosocomial infection in ICUs if we have no rational basis for decisions?"* The European Prevention of Infection in Intensive Care (EPIC study) investigated prevalence of infection in intensive care units. This study, the largest done on a pan-European basis, was the result of collaboration between 17 European countries and 1,472 intensive care units. It was conducted on one day, 29th April 1992 (Rennie 1993). Results showed nearly 45% of all patients were suffering from infection, with over 20% of the infections being acquired in ICUs.

In terms of morbidity, the most serious infections acquired in the intensive care unit are lower respiratory tract and bloodstream infections. Emmerson *et al.* (1996) conducted a prevalence of hospital-acquired infection in the UK and Republic of Ireland involving 266 intensive care patients. Patients in intensive care had the highest rates of lower-respiratory tract infection of 21.8% compared with a national prevalence of 2.4%. Pneumonia has been associated with attributable mortality rates in excess of 25% for patients requiring ventilation. Attributable mortality of bloodstream infections in intensive care units has been estimated at nearly 30% (Glynn *et al.* 1997). Glynn *et al.* (1997) conducted a three-month audit of all infections which developed in patients admitted to adult intensive care units, 20 intensive care units in 19 district general hospitals were included. The total number of patients included in the audit was 550 and 108 infection acquired in ICUs were documented. The most frequent infection was pneumonia; seventeen units reported 49 pneumonias, a rate of 9% for all 550 intensive care unit patients included in the audit. Blood stream infections were also relatively common, 11 intensive care units reported 24 blood stream infections, a rate of 4.4% for all 550 intensive care unit patients included in the audit. Data were analysed to determine risk factors for infections associated with invasive procedures. Endotracheal intubation, mechanical ventilation and the presence of a naso-gastric tube were all associated with an increased risk of intensive care unit-acquired pneumonia. All intensive care unit patients who developed a blood stream infection had one or more intravascular devices. Only five urinary tract infections and eight surgical wound infections were recorded. Glynn *et al.* (1997) highlighted that the median overall rate of intensive care unit-acquired infection of 20.4% was considerably higher than that on general wards. Data collection for the study was easier on intensive care units than on other wards, probably because of the one to one ratios of nurses to patients but Glynn *et al.* (1997) emphasised that surveillance in the intensive care unit needs to be carried out for a much longer period of time to allow a useful assessment of trends over time.

3.3 Intensive Care Nursing

In the last decade, anaesthesia and intensive therapy have made tremendous progress in life support techniques. New frontiers have opened up for advanced medical care and the increased use of sophisticated technology has been established in the intensive care unit (Carnevale 1991). The intensive care unit is held in high esteem in the medical establishment and high-technology medicine has reflected the medical model of care (Briggs 1991). Ellis (1992) described the intensive care unit as a place that provides patients with continuous observation of vital signs, constant skilled individual nursing attention and the immediate availability of medical help. Ellis drew attention to the high

degree of medical input and predominance of technological systems and suggested that this often leads to criticism that nurses in the intensive care unit are not carers but technicians. The use of the medical model of organising intensive care can become a cause of confusion to nurses caring within this setting. Boyle (1992) viewed the role of the intensive care nurse as specialised practitioner, who is highly trained and educated to accommodate the increasing demands of the critical care environment. Dunn (1992) described the intensive care nurse as integrating high-level cognitive, psychomotor and decision making skills in order to provide a safe, efficient, competent nursing care to critically ill patients. This would require nurses new to the intensive care unit to master a vast amount of theory, to manipulate multiple advanced pieces of equipment and to make crucial decisions *"on the skills of the nurse may rest the very life of another human being. This responsibility demands the utmost from the new intensive care nurse."* (Dunn 1992).

Investigating the impact of *"New Technology"* in the intensive care unit, Ireland (1985) found that the nurses interviewed felt that the most important aspect of their work in the intensive care unit was concerned with, not only physical aspects of patient care, but also with the psychological aspects. He found that the most demanding facets of the nurses' work in the intensive care unit were resuscitation of patients and dealing with critically ill or dying patients. His results suggest that intensive care nurses perceived their work as requiring a high degree of skill and discretion and that their role is psychologically and physically demanding. The nurses questioned did not feel satisfied with the level of recognition from their organisations, although they described their jobs as meaningful and making an important contribution to society.

3.4 The role of infection control nursing in the intensive care unit

Infection is not visible and traditional approaches to infection control are not adequately considering the scale of the problem. The nature of the work on the intensive care unit means that shared contact occurs between a large number of health professionals and patients. This inevitably means that transmission of resident and transient organisms from the hands of staff are more likely to occur unless strict attention is paid to hand hygiene. If routine hand hygiene precautions are not followed between patients, the potential for transmission of infection is increased. There is need to effect change through research, practice development and education whilst at the same time developing a quality assurance system which embraces current research and seeks to link infection control behaviour to outcome.

Problems of infection control in the intensive care unit should be analysed using a pragmatic approach, having first gained some understanding of theories of individual and organisational behaviour. The psychosocial basis for change requires appropriate use of education and persuasion techniques; health professionals need to clarify their roles, responsibilities, accountability and responsibility for action. The nature of intensive care nursing, the culture and the organisational climate are important factors influencing individual and group behaviour within the intensive care unit. The social sciences can provide a framework to allow an understanding of human behaviour and can be applied to the present arrangements for control of infection in the intensive care unit.

Nursing in the intensive care unit is complex and abstract; the predominant ideology in the clinical area may be the role of the nurse as technician. Neglect of fundamental nursing care may result, attitudes towards nurses working in intensive care affect individual nurses and unfulfilled competence needs may act to demotivate individuals. Milton (1981) discussed the influence of the behavioural sciences - psychology, sociology and anthropology, on the study of organisational behaviour over the past thirty years. Psychology provides insights into individual behaviour by studying perception, learning, personality and motivation. Sociology has revealed the dynamics of group behaviour by investigating norms, roles, status and power. Social psychology is the study of individual behaviour within a group that draws on both psychology and sociology. Anthropology has been concerned with peoples' learned behaviours and values as influenced by their culture. Collectively these scientific disciplines provide a body of knowledge pertaining to how people behave, why they behave as they do and the relationship between human behaviour and the total environment. Milton (1981) suggested that there is no one best solution to problems.

Each problem must be analysed in the light of all its unique complexities and a solution based upon existing factors and their interrelationships with each other. While each situation is unique, there are similarities from one problem setting to another. The importance a nurse places on the problem of hospital-acquired infection is seen as crucial to motivating compliance behaviour. Understanding perception and factors influencing perception provide a framework in order to interpret human and organisational behaviour. There is a multiplicity of intrinsic and extrinsic factors affecting the nurse working in the intensive care unit. These, in turn, influence the nurse's perception of the problem of hospital-acquired infection. The values of individuals and groups affect perception of problems, as well as the decisions and

solutions made to resolve these problems. Perception is not simply a reaction to events, people, or things; it is influenced by conditions within the individual. Although perception may correspond to actual events, no two nurses will perceive the same problems in exactly the same way. Factors influencing a nurse's perception of the problem of infection may depend upon: the physical environment, the social and cultural environment, individual needs, motives, goals, past experiences and experiences of continuous education in the intensive care unit. Because attitudes and values are learnt, they have the potential to be influenced, often in an automatic, unconscious fashion.

A nurse's ability to prevent infection is dependent on having a realistic perception of the scale of the problem and accepting a shared responsibility for a patient's microbial environment. A nurse's perception of the importance of microbiology applied to nursing practice will influence effective application of theory to clinical nursing practice. Poor compliance to local hospital policies leads to poorly performed clinical skills, thus exposing critically ill patients to the risks of hospital-acquired infection.

Chapter Four

Developing the Research Programme

The research has explored a novel, practical and potentially cheaper, way of applying research evidence in an UK setting. This programme also sought to stimulate and develop nursing practice of effective infection control; advancing the role of nurses facilitating the uptake of research evidence within the management and organisation of care and exploring the potential for changing nursing practice in infection control.

4.1 General Intensive Care Unit 1990 to 1992

This period of research involved the researcher co-ordinating clinical trials and data management in a study investigating gastric bacterial overgrowth and development of ventilator-associated pneumonia (Columb *et al.* 1992; Inglis *et al.* 1992b; Inglis *et al.* 1993a; Inglis *et al.* 1993b). The researcher also analysed responses from a national survey of infection control policies and practices in intensive care units (ICUs) in the UK (Inglis *et al.* 1992a). Following the national survey a systematic approach to preventing infection in the ICU was recommended (Sproat and Inglis 1992). During this period of research (1992-4) the researcher, supervised by an academic Microbiologist, developed and introduced a modular infection control education programme, incorporating a systematic approach to preventing ICU-acquired infection (Sproat and Inglis 1992). This involved facilitating a number of infection control practice developments in the ICU, but did not include routine audit of patient outcome for infection. The researcher also conducted a literature search and review for an MSc Dissertation which explored the *"Role of the Nurse in Preventing Hospital-acquired Infection in the ICU"* (Sproat 1992).

As a result of this multi-disciplinary research there was an increasing awareness of the quality and cost implications of hospital-acquired infections within the Trust. The researcher was asked to present a paper that analysed the infection control services in the Trust. A cost analysis, prepared by the Finance Directorate of the Trust, analysed the estimated economic burden of hospital-acquired infection. Calculations, based on an assumed hospital-acquired incidence of 5% and additional length of stay per infected patient of 4 days, showed that in bed days alone hospital-acquired infection could be costing the Trust nearly £1,000,000 per year. This excluded the costs of pathology, drugs, dressings, X-rays, physiotherapy and specialist nursing and medical interventions required by patients with hospital-acquired infection. The paper proposed that further resources be invested for enhanced infection control in the Trust.

4.2 General Surgical Unit from 1992 to 1994

Following consultation with the Health Economics Consortium, University of York, it was agreed that the Trust would fund a small controlled study in four wards - two pilot wards and two control wards. A successful research proposal submitted to Yorkshire Region Research & Development Directorate allowed this research to be extended for a full two years. This period of research built upon previous knowledge and experience gained by the researcher through working in the intensive care unit (Sproat *et al.* – in press). The primary aim of this phase of the research was to test the application of the American style "SENIC" approach to prevention of hospital-acquired infection in an UK setting. The objective of the study was to determine the benefits of targeted surveillance of a group of high-risk, general surgical patients using routine clinical data with feedback of results to nursing and managerial staff. The programme was complemented by using structured questionnaires to research issues relating to nursing education, nurses' knowledge & practice of infection control and their attitudes towards infection control. As a result of the infection audit and the questionnaire responses a research-based modular education programme was introduced for clinical nurses in two of four surgical wards. The definitions for the four site-specific infections being measured were modified from previously published studies (Glenister *et al.* 1992; Spencer 1993; Wilson *et al.* 1986a; Wilson *et al.* 1986b; Wilson *et al.* 1990; Waghorn 1994). This modification provided a means of collecting definitive clinical indicators of infection (Appendix I, Table 1) which could be identified from documented evidence in the medical case notes. The hospital-acquired infections being measured were: lower respiratory tract infection (LRTI), surgical wound infection (SWI), urinary tract infection (UTI) and blood stream infections (BSI). The method for infection surveillance was targeted to include all patients whose discharge diagnosis, as indicated by the operation codes in the computerised patient administration system (PAS), had major gastro-intestinal or vascular surgery. Data were collected in three periods, each lasting three months. From November 1992, data were collected retrospectively for July, August and September 1992, providing baseline pre-intervention measurements of the four hospital-acquired infections.

Research interventions were conducted solely by the researcher and commenced in January 1993. Interventions included: audit of the four site-specific infections; pilot ward questionnaire distribution and analysis; feedback of results to staff on pilot wards; feedback of results to managers and the introduction of an infection control educational programme on the pilot wards. Post-intervention data of hospital-acquired infection were collected in two subsequent three-month periods, the first during January,

February and March 1993 and the second during July, August and September 1993. The researcher also worked as a staff nurse on the two pilot wards during the first post-intervention period. Primary data, obtained from the computerised PAS, identified all discharged patients from the four general surgical wards during the three data collection periods. Non-surgical cases (as identified by consultant code), minor surgical cases, non-operative cases and diagnostic procedures (as identified by operation code) were identified and eliminated from the study. The study group included all patients who had major vascular or gastro-intestinal surgery during the study period. Data from the study group were cross-referenced manually with computerised microbiology data containing details of all bacteriology cultures requested from the four surgical wards. Patients from the study group who also had bacteriology requests recorded for sputum, surgical wound swab/fluid, urine or blood were identified and their medical case notes were reviewed in two stages.

Preliminary review of the case notes included examination of bacteriology culture reports, prescription sheets, temperature charts, discharge letters and clinical documentation for any written evidence of potentially acquired infection. Case notes from patients without any documented indicators of infection were excluded and the remaining medical case notes were subject to a second, more detailed review. This included collection of demographic data, risk factors, significant health care interventions and any documented indications of clinical infection. Clinical indicators for each site-specific infection were recorded in four parameters (clinical signs and symptoms of infection, positive bacteriology culture result, new or changed antibiotic prescription or written medical diagnosis of infection) and combined to determine patient outcome (Appendix I, Table2). Infections occurring more than 48 hours after admission were defined as hospital-acquired.

Results were aggregated for each three-month data collection period, providing baseline pre-intervention measurements of hospital-acquired infection and two subsequent post-intervention measurements for comparison purposes (Appendix I, Table 3). Infection rates were calculated for the study group of high-risk, surgical patients discharged from the four surgical wards and expressed as: percentage of patients affected by one or more hospital-acquired infections; overall percentage of all four hospital-acquired infections and incidence of each site-specific hospital-acquired infection. Results were reported to clinical and managerial nursing staff, commencing from January 1993 (during the first post-intervention period), and continuing throughout the study. Because hospital-acquired infection rates were higher than expected, it was

agreed to discontinue the controlled aspect of the study. The Clinical Nurse Specialist from the surgical unit was asked by the Surgical Nurse Manager to raise awareness of all staff in the four wards to infection control issues.

For the three data collection periods, the computerised PAS data included details of 2958 patients discharged from the four surgical wards, 89% patients were identified as general surgical cases and 39% patients were identified as having major vascular or gastro-intestinal surgery. This sub-group of patients were those included in the research study group. The computerised microbiology data included details of 1361 swabs or specimens sent for bacteriology culture from the four wards. A cross-match of the two databases showed that 89% of the study group also had a swab or specimen sent for bacteriology culture. Of the 1033 medical case notes requested, 98% were available for review, 504 had some recorded indication of possible infection and all 504 case notes were subject to a further review.

Results were tabulated for high-risk surgical cases in each ward for the three data collection periods (Appendix I, Graph 3). Results were presented as: average proportion of patients with one or more hospital-acquired infections; overall incidence for all four site-specific hospital-acquired infections and incidence of each site-specific hospital-acquired infection. Over the four wards, for the full nine month data collection period, 171 patients from the total 1163 (15%) of the high risk cases included in the study group were affected by one or more hospital-acquired infections.

For the full study period, January 1992 to September 1993, the overall incidence of the four site-specific hospital-acquired infections was 19%. Over the full data collection period, average percentages of infected patients across all four wards were: 21% (pre-intervention), 11% (first post-intervention) and 13% (second post-intervention). Overall incidence of all four site-specific hospital-acquired infections in all four wards over the three data collection periods was: 31% (pre-intervention), 13% (first post-intervention) and 16% (second post-intervention).

This represented an average percentage reduction of infected patients with one or more hospital-acquired infections (Appendix I, Graph 1) over the four wards from baseline to the first post-intervention measurement of 49% (from 20.94% to 10.61%), and from baseline to the second post-intervention measurement of 36% (from 20.94% to 13.45%; $\chi^2 = 7.09$ on 1df, p=0.008).

Average percentage reduction in incidence of all four site-specific hospital-acquired infections from baseline to the first post-intervention measurement (Appendix I, Graph 1) across the four wards was 59% (from 30.58% to 12.64%) and from baseline to the second post-intervention measurement 49% (from 30.58% to 15.69%; $\chi^2 = 22.35$ on 1df, p=0.0001).

An interesting pattern of results occurred in the two wards (pilot C and control D) that remained more closely matched (Appendix I, Table 4). External data collection and data feedback by the researcher on the pilot ward seemed to have an effect on patient outcome but this was gradual, but sustained process (Appendix I, Graph 2). In January 1993, during the first post-intervention period, nurses on the control ward D conducted a ward-based audit of surgical wound infection on behalf of the team of surgeons. This audit occurred outside the research study and lasted for one month and was then discontinued. Results indicated that the ward-based audit of surgical wound infection on control ward D had an immediate impact on rates of all four hospital-acquired infections in that ward (Appendix I, Graph 3).

Findings suggest that the internally managed ward-based data collection on control ward D had a stronger impact on patient outcome of infection in the short term. Control ward D had the greatest reduction in the percentage of infected patients and the incidence of the four site-specific hospital-acquired infections during the first pre-intervention period (when audit activities had taken place). It then had the lowest reduction in the percentage of infected patients and the incidence of the four site-specific hospital-acquired infections from baseline in the second intervention period (when audit activities had not taken place for five months). Baseline rates of hospital-acquired infection in control ward D were much higher than rates in the other three wards, meaning that there was more potential for improvement. The ward-based audit on the control ward appeared to have strength in immediately improving patient outcome, but this effect weakened over time when audit activities were not sustained.

Questionnaire responses supported findings of previous researchers (Akinsanya 1985; Williams and Buckles 1988; Mulhall 1990; Bartzokas and Slade 1991; Courtenay 1991; Perry and Gore 1997) which emphasised the difficulties nurses have in integrating infection control knowledge in their routine clinical practice. Findings suggested that nurses have poor knowledge and understanding of how the principles of microbiology or infection control could be applied in practice.

The study revealed nurses' lack of awareness of their potential role in infection control and confusion over recommended infection control policies and procedures. Nurses generally accepted that they needed to improve both knowledge and infection control practice, but there was lack of time and resources for study on the wards. Workload and stress amongst nurses seemed high and generally morale was low. Nurses on the pilot wards freely discussed their lack of knowledge and their own and others' variable practices in infection control. Nurses generally wanted more practical information on effective infection control. Results identified specific problems and provided a basis for improvements in infection control.

Using a retrospective approach to audit of hospital-acquired infection revealed a number of problems. Accessing and analysing information from case notes was time-consuming and caused delays in feeding back results to clinical and managerial staff. Information in the medical case notes was often missing or incomplete. Despite the difficulties experienced the research programme was acceptable to staff. Although the study was partly upset by extraneous factors, outside the control of the Researcher, results provided useful information about patient outcome obtained through systematic, objective data collection within limited resources. Accepting the limitations of this study, the approach showed potential application in a wide range of clinical specialities. The method provided a framework for case mix identification, case definition, data collection and identification of indicators for measurement of hospital-acquired infection. It was recognised that the method could be adapted to meet specific requirements of different clinical situations directly related to improving patient outcome. This study was well supported by hospital managers, who responded to the results by incorporating them within a successful business case increasing the infection control team by employing an additional four senior infection control nurses.

Identifying further potential for change

At this stage, there appeared to be potential for introducing a SENIC style approach within the UK, but several issues were identified which might weaken the impact when introduced within the NHS. Restrictive factors included: the different funding of the NHS, changing NHS priorities, different approaches to infection control, limited resources, limited infection control personnel. In addition there are difficulties in teaching and learning of infection control, an obvious theory-practice gap, inability to expose health professionals to repeated influencing tactics and inability to monitor the effectiveness of interventions. More general restrictions to practice development would include: changing work patterns, difficulties in recruitment and retention of staff, poor job satisfaction and

low morale. Building on the available research evidence and local experience, it became obvious that nurses could make a greater contribution to effective infection control, but that multiple strategies would be required to influence their compliance with infection control recommendations. Ideal strategies would incorporate audit of infection with feedback of rates to nursing staff with appropriate, responsive infection control education.

Considering the restrictive factors and evidence of low motivation for compliance there would need to be external facilitation for change and that facilitator would need to understand the nature of the problems in context with the clinical area. Sustained change would require transfer of the problems, issues and potential solutions to nurses. The focus would need to be on the nurse's role and nursing infection control clinical practices. Whilst quality improvement has its own unique methods and influencing tactics, further research in this field would need to be supported by knowledge derived from psycho-social theories of human motivation and behaviour. The knowledge and skills gained from the research programme led to the development of a research proposal to develop and test a prospective method of auditing infections acquired by patients requiring intensive care.

Intensive care was chosen because of the higher risk posed to critically ill patients requiring invasive therapies and treatment to support failing vital functions. The costs of intensive care are high, with media attention closely fixed on the difficulty of limited ICU beds nationally. Difficulties are faced if patients who acquire infection need to stay within the ICU environment for long periods; beds are blocked for emergencies and reserved beds for booked admissions to ICU are not available meaning operations need to be cancelled. This impacts on waiting lists for serious surgery. All these factors can impact, not only on costs, but also on the management, organisation and delivery of routine health care services.

Whilst a national programme of audit was being developed, the problems facing such research are well documented. Difficulties arise in professional agreement of case definitions and methods of surveillance. The priority is seen as developing systems of measurement that can be compared across different sites. Whilst this is a desired element which addresses the needs of standard setting and quality improvement, the associated need for research rigor delays clinical progress in this field of study. The confidential nature of infection data collected nationally means that not all clinical staff who are involved in studies are aware of the local results.

4.3 Developing the Research Method

The observations made within the previous study and further reviews of the literature influenced the development of the current research programme. This programme has attempted to adopt a practical, clinically useful approach to the problem of hospital-acquired infection and infection control. The researcher wanted to develop a method to routinely audit hospital-acquired infection which supports increasing the knowledge and infection control practice development without relying on expert infection control input or major additional resources. The proposed bedside audit of hospital-acquired infections would incorporate modified definitions for hospital-acquired infections and provide the means of prospectively auditing risk factors, process measures and outcome for infection within routine documentation.

The study aimed to improve the prevention and management of four categories of site-specific infection acquired by patients in intensive care units: lower respiratory tract infection (LRTI), blood stream infections (BSI), surgical wound infection (SWI) and urinary tract infections (UTI). The emphasis in this study was on testing theory derived from evidence of large scale research and exploring the potential for improvements in quality of care, patient outcome or resource utilisation in the ICU before recommending future strategies for infection control. The research sought to: promote local ownership and control of audit data; improve documentation of clinical information related to acquired infection; improve the clinical information base; support the identification of local infection control problems; inform and educate staff; aid decision-making and influence changes in clinical practice. The study was designed as a methodological study and developed within a pragmatic (before and after) controlled study. Whilst the methodology to determine the impact of the intervention on patient outcome used a quantitative approach, the research focused on the potential for behavioural change.

Working practices and confounding variables within an ICU are difficult to predict or control. An exploratory use of the conceptual framework of action research and the application of Lewin's theory of change was chosen to underpin this research. Hart and Bond (1995) cite Allport (1948) who highlighted that the overall theme of action research is that, *"the group to which an individual belongs is the ground for his perceptions, his feelings and his actions".* This view concurred with the researcher's previous analysis of intensive care and the role of intensive care nurses in infection control (Sproat 1992). Lewin (1958) described the cycle of change in four key stages: *"unfreezing"* - a period of coming to terms with the need for change; introducing new values; a period of accepting these new values and a period of consolidation.

Hart and Bond (1985) described action research as educative; deals with individuals as members of social groups; is problem-focused, context specific and future-orientated; involves a change intervention; aims at improvement and involvement; involves a cyclical process involving research, action and evaluation and is founded on a research relationship in which those involved are participants in the change process. After reviewing the literature in action research the approach suited the researcher's personal philosophy about the change process. In common with Hope (1998) the researcher became aware that previous studies had involved the researcher as a *"research intervention"*. The research programme had been developed using a systematic, yet informal, change process without the researcher being consciously aware of the impact of this approach on the change process.

4.4 Study Aim

The study aimed to develop an acceptable, reliable method to audit the incidence of four categories of site-specific infection acquired by patients in intensive care units. These infections were lower respiratory tract infection (LRTI), blood stream infection (BSI), surgical wound infection (SWI) and urinary tract infections (UTI).

4.5 Research Objectives

a) To identify and agree by consensus, a clinical data set to audit four categories of site-specific ICU-acquired infection.

b) To develop a protocol for clinical audit of the four ICU-acquired infections, using routinely collected clinical data and to develop this protocol within an effective audit tool.

c) To manage and support the introduction of this audit tool in a pilot site and at least two large adult intensive care units.

d) To evaluate staff response to the audit and determine the impact of the audit on patient outcome and resource utilisation.

e) To validate the audit tool and evaluate its utility in providing information which effectively supports management and prevention of ICU-acquired infection.

f) To effectively manage research data
   - data management within each research site
   - computerised tabulation of raw data
   - data analysis, collation, interpretation and presentation
   - dissemination of results

g) To develop, facilitate and support an appropriate education programme that was be to based on local and generic problems identified by the audit and from feedback of information from staff questionnaires.

4.6 Research Design

It was intended that the research would be conducted in at least four research sites from two different health regions. The impact of prospective audit, conducted by ICU staff in a pilot and intervention site, was to be evaluated in comparison to the impact of retrospective audit, conducted by the researcher in a comparison cross-over site using the same data set in both methodologies. The feedback of infection incidence in the pilot and intervention sites would be continuous during the period of research; in contrast to retrospective audit with delayed feedback of infection incidence in the comparison cross-over site. Trends of ICU-acquired infection incidence in these three sites were to be compared with trends of ICU-acquired infection in another ICU, one with no mechanisms for any audit of infection during the study period. It was planned that the researcher was to act as internal change agent in the ICUs, becoming an integral member of the ICU team. This would be followed by a planned period of researcher withdrawal and post-intervention evaluation.

4.7 The Research Hypothesis

That the introduction of prospective audit of patient risk factors and outcome measures for hospital-acquired infection will result in improved healthcare practices and this improvement will be reflected in reduction of infection incidence.

4.8 Research Questions

1. Can key patient risk factors and outcome measures for hospital-acquired infection be identified and collected from existing data sources?

2. Can these data items be integrated into a practical audit tool for measuring incidence of hospital-acquired infection in a rigorous, scientific way?

3. Is it practical to incorporate this audit tool into routine documentation of clinical care in a cost-efficient way?

4. What impact would this have on standards of clinical care and patient outcome?

4.9 Research sites and Interventions

Site 1	**Pilot site: regional 5 bedded Paediatric ICU**
Interventions:	comparison retrospective audit from January 1994 onwards
	continuous prospective audit - all admissions from June 1995
	feedback of infection incidence to staff from June 1995
Sites 2 and 3	**Adult ICU Intervention sites**
Interventions:	comparison retrospective audit from January 1994 onwards
	continuous prospective audit - all admissions from June 1996
	feedback of infection incidence to staff from June 1996
Site 4	**Comparison site: regional 5 bedded Paediatric ICU**
Interventions:	comparison retrospective audit from January 1994 onwards
	no intervention and no feedback until end of study
Site 5 and 6	**Adult ICU Comparison sites**
Interventions:	comparison retrospective audit from January 1994 onwards
	no intervention and no feedback until end of study

4.10 Gaining Access to the Research Sites

General approval for the study was required from ICU nurses and doctors, the Infection Control Team and members of the relevant hospital management team. Arranging formal clinical access and ethical approval involved gaining access and permission to use hospital data, clinical ICU data and microbiology data in both paper-based and computerised formats. Approval was also needed for data protection, data security and data management plans, including the proposed data analysis, presentation and research dissemination. A large amount of the researcher's time was spent negotiating access to the six possible research sites. Exploratory visits, information gathering and consultation included all six sites. Two of the four proposed adult ICU research sites would not consider allowing nurses to collect data (although they would have allowed the researcher access to collect data). These two sites were then eliminated from the study.

The proposed cross-over control adult ICU was included in all of the early stages of the research, clinical access and ethical approval was obtained for the study, but the ICU would not allow full introduction of bedside audit system. At this stage it was felt better that the site remained as control. In this site, computerised ICU data was obtained on all

patients staying over 48 hours and computerised pathology data was obtained on bacteriology specimens requested from all admissions, but this data did not contain results of the cultures. Previous experience in this ICU meant that the researcher has anticipated that bacteriology results and antibiotic changes would be recorded on ICU patient's observation charts. Two hundred and ninety-six micro-fiched patient observation charts were audited, but although the charts did contain some results of bacteriology cultures, there was no record of antibiotic changes. This meant the researcher would have needed to audit all the case notes from patients on this ICU to achieve a sensitive control. This was not achievable in the time; therefore this site did not progress within the study.

Because of the high workload for the researcher and the length of time taken up with negotiating access to six sites, it was decided to have the proposed cross-over PICU as control for the pilot PICU. Again this site was included in lengthy negotiation for clinical access and ethical approval. Computerised PICU data was obtained along with computerised pathology data. Patients who stayed longer than 72 hours and had bacteriology samples sent for culture were identified. The pathology data contained results of cultures but they were not in a useable format and again this would have meant auditing around 250 case notes. A system for accessing the case notes was negotiated including payment for rapid access, but because of internal pressure on the medical records department and the need to write up this study, this phase of the study will need to be completed after submission. For these reasons it was only possible to include one pilot site and one intervention site.

The system of audit developed for this research was to be applied to all patients admitted to two research sites from two different health regions, involving a total study population of over 2000 patients. The method of audit was designed to capture the key information obtained from routine sources. Feedback of infection incidence in the pilot and intervention site was to be continuous during the period of research. Incidence of the four hospital-acquired infections was to be measured using nurses to collect and co-ordinate data collection. All research interventions and infection control educational activities introduced within this study were to be supported and facilitated by the researcher. Data collection for each patient was to include risk assessment with collation of routine clinical and microbiological data and objective measurement of patient outcome combining clinical and microbiological data variables. Retrospective audit was to be used to compare pre- and post-intervention rates of ICU-acquired infection and to validate the prospective audit methodology.

4.11 Ethical Considerations

The issue of introducing non-validated audit tools

The method of prospective audit developed for this research had not been validated. It had been adapted from previous research that had used expertly derived definitions for infection and surveillance methodologies. These definitions had been validated within discreet research programmes, but not used or tested in routine clinical work.

Use of multiple research sites

The audit was to be applied in multiple sites. Trends of infection in ICUs were to be analysed to determine the impact of, and responses to, different approaches for auditing acquired infection. Results would indicate the potential for generalisabilty of the research to further clinical sites.

Impact on patient care or costs of care

No patient interventions were to occur and no additional tests or specimens were to be required for this research, therefore no inconvenience was anticipated to patients or relatives. For each site, audit information would indicate where quality improvements could be made and the study will try to identify measurable improvements in quality of care, resource utilisation and patient outcome.

Use of clinical nursing time

Data collection by staff for the audit and responses to the questionnaires were to be voluntary and the audit tool was designed to utilise routinely collected data items that would be readily available in the ICU. All data items to be collected were to be agreed with each ICU team before introduction. Data items were fully coded to facilitate speed of data collection.

Anonymous use of data and data protection

The research was to use anonymised data collected from routine clinical records and responses from ICU staff gained through questionnaires and direct discussion. Research data was only to be used for the study.

4.12 Statistical Considerations

The emphasis in this research study was to be on developing nursing practice for effective infection control. However the temporary nature of changes in infection control practice previously noted in the literature meant that a research design using either quantitative or qualitative methods alone would not realistically support sustainable change in effective infection control practice. An increased potential for change might be achieved when action research, practice development and change management were supported by time- and cost-efficient use of routinely available clinical information for infection surveillance. Choice of a positivist, rational approach using empirical evidence might be a more successful influencing tactic on the behaviour & attitudes of medical staff and on encouraging hospital managers & decision-makers to support the research programme. In contrast, utilising action research using a naturalistic, intuitive approach would be a valid choice of research method to address a clinical problem that appeared to require change in behaviour that might be best delivered through use of psycho-social influencing tactics. Therefore, whilst the methodology to determine the impact of the intervention on patient outcome was quantitative in nature, the research focused on nurses' behavioural changes and was underpinned by the exploratory use of action research and application of Lewin's theory of change.

Whilst no precise outcome could be predicted, the researcher set out with a specific purpose, to develop and implement a method for bedside audit of infections acquired by patients requiring intensive care and test its implementation in clinical practice. However, the focus in this study would be on monitoring outcomes rather than explaining the factors which may or may not have been changed by the research interventions - information gathering, education, audit of infection with feedback of results. The result being use of combined evidence-based methods and interventions aimed at improving infection control through influencing the cognitive and behavioural components of nursing infection control practice.

The research was initiated as a methodological, evaluative pragmatic study that adopted a time-series intervention drawing on both quantitative and qualitative research methodologies. The research sought to test the integration of the data items into a practical audit tool for measuring incidence of hospital-acquired infection in a rigorous, scientific way. Research results were to be judged by the extent to which the research interventions met the research objectives and the degree to which results could be used to answer the four research questions.

Data analysis aimed to describe and summarise the results. The research hypothesis that audit would impact on behaviour resulting in reduced infection rates would be tested by comparing pre- and post-intervention measures of ICU-acquired infection and the relationships between them. In determining the effectiveness of identifying patient risk factors and outcome measures for hospital-acquired infection from existing data sources, evaluation would consider the ICU staff's acceptability of the research tool. All professional groups working within and outside the ICU would need to accept the face and content validity of the audit methodology. Face validity refers to whether an instrument looks as though it is measuring site specific hospital-acquired infections (Pollit and Hungler 1995). The content validity would be based on judgement and assessed by professional consultation and consensus development. The practicality of incorporating the audit tool into routine documentation of clinical care would consider the clinical utility of the audit methodology. Evaluation would consider: the objectivity of the tool, the potential bias in responses, the time taken to complete the audit, the ability to identify individual infections and the tool's simplicity (Pollit and Hungler 1995). Assessment of practicality in use would be achieved using questionnaire responses and feedback from staff using the bedside documentation. The focus would be on staff acceptability and compliance with completing the documentation. Evaluation would determine whether completion of the documentation can be included as part of normal working practices.

Chapter Five

Research Methods

This section describes the activities in the two ICUs that adopted and tested the full infection control care planning and audit system. The system of audit developed for this research was applied to all patients admitted to the two ICUs in two different health regions. The pilot site was a 6-bedded paediatric intensive care unit and the other site was an 8-bedded general adult intensive therapy unit (GITU). The acronym ICU will be used within the research protocol when referring to both units. PICU and GITU will be used to distinguish the two units from one another. This section describes research activities that were common to both ICUs, differences will be highlighted in separate sections.

5.1 Profiling the Research Sites

This questionnaire was a modified repeat of the National and Regional Surveys of Infection Control in intensive care units (Inglis *et al.* 1992b; Sproat and Inglis 1994). It was completed by a senior nurse and included the ICU profile, nursing and medical staffing arrangements for the unit and an audit of infection control policies and practices. It also required that a plan of the ICU be drawn up showing positions of wash basins in relation to beds. The Researcher collated additional background information that explored the available ICU information sources that might be used for the research data collection.

5.2 Questionnaire distribution and analysis

Before any research interventions or educational sessions, a questionnaire was distributed to all ICU staff. This questionnaire was developed from those used by previous researchers (Williams and Buckles 1988, Horton 1992, Horton 1993), but was modified to ensure that the questions contributed to raising awareness of the problems of infection control in ICUs. It used semi-structured questions to investigate nurses' infection control education and knowledge and their attitudes towards infection control and microbiology. It questioned staff on their use of infection control within patient assessment and care planning. It also allowed staff to give their suggestions for improving infection control in three key areas: infection control in their ICU; communication of infection control policies; infection control education and allowed suggestions for topics to be incorporated within an education programme for the ICU.

5.3 Research Support

All research interventions and infection control educational activities introduced within this study were introduced, supported and facilitated by the researcher. During the research sufficient time was allowed:

- to negotiate multi-disciplinary access to the ICU
- to negotiate access to the computerised ICU and pathology data;
- to apply for and receive Ethical Approval
- for each ICU to initially receive a series of introductory research seminars
- for a group of nurses to volunteer to support this research programme.

5.4 Determining the minimum data set

In order to achieve high inclusion of patients into the study, it was intended that all data items were collected from all patients admitted during the study period. Patient risk factors, significant clinical care processes and clinical criteria for the presence or absence of hospital-acquired infection was be agreed as a minimum data set to be incorporated into the data capture tool.

5.5 Data collection

After a period of educational and audit training seminars, nurses were asked to collect data on the incidence of four site-specific ICU-acquired infections. Retrospective data was collected for PICU from January 1994 until June 1997 and in GITU from January 1994 to may 1997. The retrospective data collection used the same data items as the prospective bedside audit, but utilised secondary sources of routinely collected clinical and microbiological data recorded in the computerised clinical and pathology information systems and within patients' case notes.

5.5.1 The infection control and audit care plan

This complete system for infection control care planning and audit did not require special expertise or knowledge in determining patient outcome for ICU-acquired infection. All information required to conduct the prospective audit was contained within the research documentation and was contained within a waterproof folder that remained at the bedside. Data items were coded, where possible, to reduce time completing the forms. To minimise staff time taken with administration of the research a system was introduced that, on a patient's discharge, the research folder was completed and placed in a box file and a new folder taken from a

second box file and placed at the bed space. The researcher or research co-ordinator removed completed data forms from the folders and replaced them by new forms, ensuring staff always had sufficient documentation at the bed space and in the files. For both ICUs there was an introductory period involving communication with staff agreeing the infection control care plans that were modified to local specifications. Data were collected prospectively by nursing staff at the bedside and utilised clinical and microbiological data from primary ICU sources, i.e., from nursing and medical records and associated computerised clinical information systems for each patient admitted to the unit. Prospective data collection used ICU nursing staff to manage data collection, collation and communication within the ICU. These activities were facilitated by the researcher and co-ordinated by a member of the ICU nursing staff. Structured data collection, collation, analysis, interpretation and evaluation was conducted using clinical and microbiological primary data sources readily available in the units. Significant intensive care interventions and patient outcome events were documented and variations in these processes identified. The complete coded audit and care planning system included the following stages:

- patient risk assessment for ICU-acquired infection
- following or adapting a standard ICU-specific infection control care plan
- recording bacteriology swabs sent and results received
- daily evaluation of patient infection status
- recording positive outcome indicators for each infection in four parameters
- recording patient outcome for each of the four ICU-acquired infections

5.5.2 Defining an ICU-acquired infection

An ICU-acquired infection was identified as an infection that was not present or incubating at the time of admission. ICU-acquired infections occur 48 to 72 hours after admission to the ICU (Crowe and Cooke 1998). After preliminary audit of records during the first six months of the pilot in the PICU, it was agreed to define an ICU-acquired infection as an infection that was not present or incubating at the time of admission to the ICU, but which occurred 72 hours or more after admission (Glenister *et al.* 1992)

5.5.3 Staging site-specific infection

Development of an ICU-acquired infection needed to be made explicit within the documentation and data collection. Early pre-infectious indicators of each site-specific infection were sub-categorised into stages within the audit tool. Generally the stages followed the infection processes that nurses would, or should readily know. The research documentation included guidance for staff on the associated clinical signs and symptoms that may occur for each site-specific ICU-acquired infection.

Stage	General infection status
0	Patient at risk - no positive indication of infection
1	Possible pre-infectious indicators of infection
2	Probable indications of infection
3	Actual infection

5.5.4 Objective measurement of patient outcome

For each of the four categories of hospital-acquired infections to be investigated, LRTIs, BSIs, SWIs and BSIs, measurement of patient outcome was determined by combining four clinical and bacteriological parameters (Appendix I, Table 2). For each site-specific ICU-acquired infection being measured, coding combined the stages of infection with the four parameters. The parameters to be measured were: a).clinical signs and symptoms of infection; b). positive bacteriology results; c). change of antibiotic and d).written medical diagnosis of infection. This meant the rationale for determining presence or absence of an ICU-acquired infection was made obvious to everyone involved in the study and to the Researcher in the data analysis. To assure a systematic approach to recording patient outcome as positive for a site-specific ICU-acquired infection, there had to be evidence of 2 or more positive indicators (parameters a, b or c) and/or written medical diagnosis of a site-specific infection (parameter d). Therefore, when considering infection status for each site-specific infection being measured the parameters can be combined using the algorithm as follows, if parameters

(a = yes) and (b = yes)	then ICU-acquired infection = yes;
(a = yes) and (c = yes)	then ICU-acquired infection = yes;
(b = yes) and (c = yes)	then ICU-acquired infection = yes;
(a = yes) and (b = yes) and (c = yes)	then ICU-acquired infection = yes;
(d = yes)	then ICU-acquired infection = yes

Else ICU-acquired infection = no

5.6 Data collation, management and analysis

Section 5.6 Table 1: stages of data collation

Data collection	Data set	Methods	Final data set
Retrospective audit	Computerised ICU data	Sort by length of stay	**Data Set A** ICU admissions staying > 72 hrs
Retrospective audit	Computerised pathology data	Sort by sample type (both ICUs) and by result if available (GITU only)	**Data Set B** Pathology specimens and results
Retrospective audit	Data sets A and B	Combine data sets A and B to identify ICU admissions staying>72 hours who have samples sent (PICU) or positive results (GITU)	**Data set C** ICU admissions staying >72 hours with bacteriological indicators for infection
Retrospective audit	Case notes	First review of documentation to identify positive indicators for infection	ICU admissions staying >72 hours with bacteriological and clinical indicators for possible infection
Retrospective audit	Case notes	Second review detailed collation of clinical and microbiological data	**Data set D** ICU admissions staying >72 hours with bacteriological and clinical indicators for probable infection
Retrospective audit and Bedside audit	Data set C and Bedside documentation	Using pre-defined definitions and infection staging, collate and code clinical and microbiological data into infection stages (0,1,2,3 or 4) and parameters (a,b,c or d)	**Data set E** Study group with positive outcomes for LRTI, BSI, SWI and UTI

Chapter Six

Results

6.1 The Paediatric Intensive Care Unit Profile

At the start of the study the PICU was a six-bedded regional unit that was initially funded to have four beds open, the unit opened to five beds in February 1995 and then to six beds in December 1996. There were two side rooms for isolation purposes. Average bed occupancy in the year April 1993 to April 1994 was 82%, with a total of 178 children admitted to the unit during the year 1993-4 with 75% of children intubated. There was an average of 5 nurses on duty on each shift with a nurse/patient ratio of 1:1. The PICU had a total of 35 nursing staff, 8 with more than 3 months experience of ICU, 1 with more than 6 months and 26 nurses had more than one year's experience of ICU. Three nurses had the ENB 100 certificate (Intensive Care) and 15 had the ENB 415 certificate (Neonatal Intensive Care). The ICU Director was a Consultant Anaesthetist with one other Consultant Anaesthetist on the PICU team. Both consultants had other responsibilities in operating theatres. There were four clinical research fellows, two paediatricians and two anaesthetists. In the PICU there were also arrangements for on-call medical consultants in anaesthetics, surgery, neurosurgery and neurology if required. There were written policies relating to control of infection for total parenteral nutrition (TPN), endo-tracheal suctioning, the type of hand wash agents to use in the unit and a written policy for universal precautions. Verbal policies were in place for: insertion and care of central and arterial vascular devices and lines, time to change ventilator tubing, terminal cleaning of ventilators, urinary catheter insertion, meatal care; taking a catheter specimen of urine and technique for hand washing. There were no policies for: pulmonary artery catheter insertion; Swann-Ganz catheter insertion; re-filling of water chambers on ventilators; time to change urinary catheters; emptying of urinary drainage bags; oral hygiene or for any aspect of surgical wound care. The *'Royal Marsden Hospital's Manual of Clinical Procedures'* (Pritchard and Mallet 1992) was used to guide nurses in their clinical practice. There were four sinks in the PICU; one in each of the side wards and two in the main clinical area. One sink would be best described as a "social hand wash area" with the other one being a "clinical" sink for four beds. The minimum distance from a bed space to a hand basin was 2 metres and the maximum was 4 metres.

6.2 PICU Questionnaire Responses

6.2.1 Infection Control Education, Knowledge and Practice

Responses were received from four doctors and 21 nurses. In the sample of doctors responding, one was a Consultant, two were Senior Registrars and one was a Research Fellow. Response rate from registered nursing staff was 60% (21/35) with the sample comprising four G grade nurses, five F grade nurses, eleven E grade nurses and one D grade nurse. Results are presented for all staff and for nurse responses[1].

Reading and understanding bacteriology reports

The majority of staff responded that they always or sometimes read bacteriology reports, but only 44% always read them and only 24% responded that they always understood them. Two doctors always read bacteriology reports, the other two sometimes read them and all doctors understood reports. Eight of the twenty-one nurses always read the reports, but only two (both G grade nurses) always understood them. Twelve nurses sometimes read the reports and seventeen sometimes understood them. One nurse (E grade) sometimes read them, but rarely understood them. One E grade nurse never read bacteriology reports and never understood them.

Do you always read bacteriology reports?

Responses	n	Always	Sometimes	Rarely	Never
all	25	40%	56%	0%	4%
nurses	21	38%	57%	0%	5%

Do you always understand bacteriology reports?

Responses	n	Always	Sometimes	Rarely	Never
all	25	24%	68%	4%	4%
nurses	21	10%	81%	5%	5%

Incorporating bacteriology culture results into patient care plans

Only 21% of staff responded that they always incorporated bacteriology results in the patient's care plan, with 54% doing so sometimes. All three doctors who

[1] The sample size from the questionnaire was small - percentage responses have been rounded up to whole numbers for ease of reading, rather than for mathematical accuracy, therefore responses do not total 100%

responded to this question felt they always incorporated results of bacteriology reports, but 29% of the nurses rarely or never incorporated them.

Do you incorporate the results of bacteriology reports in your patient's care plan?

Responses	n	Always	Sometimes	Rarely	Never
all	24	21%	54%	17%	8%
nurses	21	10%	62%	19%	10%

Assessing and documenting patient risk of acquiring an infection in hospital

Eighty percent of staff responded that they always or sometimes assessed risks, but no respondents reported always recording them. Two doctors reported that they assessed patients' risks of acquiring infection sometimes, one responded rarely and one never. One doctor sometimes recorded these risks, two rarely and one never. Eighty-six percent of nurses always or sometimes assessed patient risks, 10% rarely and 5% never. Forty-eight per cent of nurses sometimes documented the patients' risks of acquiring an infection, 43% rarely and 10% never documented the patients' risks of acquiring an infection.

Do you routinely assess your patients' risks of acquiring an infection?

Responses	n	Always	Sometimes	Rarely	Never
all	25	24%	56%	12%	8%
nurses	21	29%	57%	10%	5%

Do you document your patients' risks of acquiring infection?

Responses	n	Always	Sometimes	Rarely	Never
all	25	0%	44%	44%	12%
nurses	21	0%	47%	43%	10%

Documenting the presence of a hospital-acquired infection

Two doctors and four nurses responded that they always documented the presence of an acquired infection. Two doctors and 12 nurses (56%) responded that they sometimes did so, but 5 of the 21 (24%) nurses responded that they rarely or never recorded this information.

Do you document the presence of a hospital-acquired infection?

Responses	n	Always	Sometimes	Rarely	Never
all	25	24%	56%	12%	8%
nurses	21	19%	57%	14%	10%

Adequate planning and delivering care aimed at reducing risk of infection

Forty percent of staff responded that though they always adequately planned and delivered care to reduce the patients' risks of acquiring infection, with 48% responding doing so sometimes. Two doctors felt they always planned and delivered adequate care and two responded that sometimes they did. Three doctors rarely documented this care and one never did. Eighty-six percent of nurses felt they always or sometimes adequately planned and delivered care to reduce risks, with the most frequent response being that they felt they did sometimes. Three nurses felt they rarely planned and delivered adequate care in this respect (two E grade nurses and one D grade nurse), and one nurse never documented this care aimed at reducing risks of acquiring infection.

Do you consider you adequately plan and deliver care which aims to reduce the risk of your patient acquiring an infection?

Responses	n	Always	Sometimes	Rarely	Never
all	25	40%	48%	12%	0%
nurses	21	38%	48%	14%	0%

Do you document care which is aimed at reducing the risk of your patient acquiring infection?

Responses	n	Always	Sometimes	Rarely	Never
all	25	24%	44%	24%	8%
nurses	21	29%	52%	14%	5%

Knowledge of infection control and pre- and post registration education

Only 42% of the 24 PICU staff responding to this question felt that their knowledge of microbiology and infection control was adequate for prevention of infection in patients requiring intensive care and 50% of the nurses (10/20) did not. One doctor and three nurses did not know. The three doctors who responded to this question and 15 of the 21 nurses responded (71%) that they felt their pre-registration education/training for infection control did not provided sufficient knowledge for effective infection control in practice. One nurse did not know. However all three doctors responding and 76% of the nurses had gained further knowledge in infection control since basic pre-registration training.

Do you think your knowledge of microbiology and infection is adequate for prevention of infection in patients requiring intensive care?

Responses	n	Yes	No	Don't Know
all	24	42%	42%	17%
nurses	20	35%	50%	15%

Do you consider your pre-registration education/training for infection control provided sufficient knowledge for effective infection control in practice?

Responses	n	Yes	No	Don't Know
all	24	21%	75%	4%
nurses	21	24%	71%	5%

Have you had the opportunity to gain further knowledge in infection control since your basic pre-registration training?

Responses	n	Yes	No	Don't Know
all	24	79%	21%	0%
nurses	21	76%	24%	0%

The majority of staff had never taught microbiology or infection control, and only 48% of staff felt they teach this at a basic level.

Have you ever taught microbiology or infection control?

Responses	n	Yes	No
all	25	12%	88%
nurses	21	14%	86%

Could you teach basic microbiology or infection control?

Responses	n	Yes	No
all	25	48%	52%
nurses	21	48%	52%

Identifying potential for change

Seventy-two percent of all respondents felt that there was a need to change the approach to infection control in the ICU and 92% thought that there was potential for improving infection control practices

Do you think there is need for change in approach to infection control in the ICU?

Responses	n	Yes	No	Don't know
all	25	72%	8%	20%
nurses	21	76%	5%	19%

Do you think there is potential for improving infection control practices?

Responses	n	Yes	No	Don't know
all	25	92%	0%	8%
nurses	21	95%	0%	5%

6.2.2. Hand hygiene practices and knowledge of policies

Staff were asked to record their hand hygiene practices for five clinical procedures. The five procedures were: routine IV line change, endo-tracheal tube suction, surgical wound dressing, emptying urinary catheter drainage bags and oral hygiene. Only responses from nurses were analysed. With the exception of two nurses, all the nurses who responded to the questionnaire reported conducting some type of hand hygiene (hand wash and/or alcohol rub) before and after each of the five clinical procedures. The exceptions were two nurses, who responded that they did not hand wash or use alcohol rub before emptying urinary catheter drainage bags, although they did use non-sterile gloves.

Routine intra-vascular (IV) line change

There was a verbal unit policy for insertion and care of central and vascular devices and lines. Thirteen nurses (65%) thought the policy for routine IV line care was written, 3 correctly thought it was verbal, 1 thought there was no policy and 4 nurses did not know what type of policy there was.

Section 6.2.2. Table 1: PICU nurses' hand hygiene practice (routine IV change)

Routine IV change*		Hand hygiene	N	n	% response
	before	Hand wash only	21	9	43%
		Alcohol rub only		2	10%
		Hand wash & alcohol		10	47%
	during	Sterile gloves	21	5	24%
		Non-sterile gloves		2	10%
		No gloves		14	66%
	after	Hand wash only	21	11	52%
		Alcohol rub only		9	43%
		Hand wash & alcohol		1	5%
Verbal PICU policy		Written	20	13	65%
		Verbal		3	15%
		None		0	0
		Don't know		4	20%

Endo-tracheal (ET) tube suction

There was a written policy for ET suctioning, 56% of nurses responded correctly, 4 thought it was verbal and 4 did not know what type of unit policy there was.

Table 6.2.2.Table 2: PICU nurses' hand hygiene practice (ET tube suction)

ET tube suction	Hand hygiene	N	n	% response
before	Hand wash only	*21*	11	53%
	Alcohol rub only		7	33%
	Hand wash & alcohol		3	14%
during	Sterile gloves	*21*	0	0
	Non-sterile gloves		21	100%
	No gloves		0	0
after	Hand wash only	*21*	14	66%
	Alcohol rub only		2	10%
	Hand wash & alcohol		5	24%
Written PICU policy	Written	*18*	10	56%
	Verbal		4	22%
	None		0	0
	Don't know		4	22%

Surgical wound dressing

There was no policy related to infection control for this practice. Of 19 nurses responding, 10 thought there was a written policy for surgical wound dressing, 1 thought that it was verbal, only 1 nurse correctly thought there was no policy.

Section 6.2.2. Table 3: PICU nurses' hand hygiene practice (ET tube suction)

Wound Dressing	Hand hygiene	N	n	% response
before	Hand wash only	*21*	11	52%
	Alcohol rub only		0	0
	Hand wash & alcohol		10	48%
during	Sterile gloves	*21*	16	76%
	Non-sterile gloves		1	5%
	No gloves		4	19%
after	Hand wash only	*21*	14	67%
	Alcohol rub only		0	0
	Hand wash & alcohol		7	33%
No PICU policy	Written	*19*	10	53%
	Verbal		1	5%
	None		1	5%
	Don't know		7	37%

Urinary drainage bag emptying

There was no unit policy for this practice. Eighteen nurses responded - 4 thought there was a written policy, 4 thought it was verbal, 1 thought there was no policy and 9 did not know what type of policy there was.

Section 6.2.2. Table 4: PICU nurses' hand hygiene practice (urinary drainage bag)

Emptying urinary drainage bag		Hand hygiene	N	n	% response
	before	Hand wash only	*21*	8	38%
		Alcohol rub only		6	29%
		Hand wash & alcohol		5	24%
	during	Sterile gloves	*21*	0	0
		Non-sterile gloves		21	100%
	after	Hand wash only	*21*	14	67%
		Alcohol rub only		0	0
		Hand wash & alcohol		7	33%
No PICU policy		Written	*18*	4	22%
		Verbal		4	22%
		None		1	6%
		Don't know		9	50%

Patient's oral hygiene

There was no unit policy for this practice. Seventeen nurses responded - 3 thought it was written, 4 nurses thought it was verbal, 2 nurses did not think there was any type of policy and 8 did not know.

Section 6.2.2. Table 5: PICU nurses' hand hygiene practice (oral hygiene)

Oral hygiene		Hand hygiene	N	n	% response
	before	Hand wash only	20	14	70%
		Alcohol rub only		3	15%
		Hand wash & alcohol		3	15%
	during	Sterile gloves	20	0	0
		Non-sterile gloves		15	75%
	after	Hand wash only	20	14	70%
		Alcohol rub only		2	10%
		Hand wash & alcohol		4	20%
No PICU policy		Written	17	3	18%
		Verbal		4	24%
		None		2	12%
		Don't know		8	47%

6.2.3 Hand hygiene compliance

PICU staff were asked to give their reasons, chosen from a pre-defined list, as to why research indicates that health professionals have poor compliance with recommended infection control practices. All 25 respondants answered this question. The most common responses were, *"confusion over correct procedures"* was indicated by 80% of staff (20/25), followed by *"shortage of time"* indicated by 72%. Forty-four percent indicated *"forgetting"*, *"poor hand washing facilities"* by 32% and *"not always necessary"* by 1 nurse. Eleven staff made additional comments relating to this section of the questionnaire.

Table 6.2.3, Table 1

Additional comments made by PICU staff about non-compliance

- *"Resuscitation procedures occasionally sub-optimal"*
- *"What are recommended procedures? -anyway I thought doctors were sterile!!?*"*(comment from a doctor)
- *"Problems in emergency situations"*
- *"Non-compliance from doctors"*
- *"not always necessary- as I don't think practices researched on large adult ICUs are always relevant- need more audit of what we do here"*
- *"shortage of time" most important reason, particularly with IV line changes - setting up inotropes etc"*
- *"Much prefer to use vinyl non-sterile gloves, would probably use them more than latex-type glove currently used on the unit"*
- *"Not being bothered i.e., medics (not fellows)"* (comment from a nurse)
- *"Not always a priority if a child is sick, if a child is critically ill or a crisis occurs infection control is not an priority, lines (IV) are broken ASAP etc. attempts are made to be clean, but often not sterile- no touch technique at best"*
- *"Laziness"*
- *"Poor hand washing facilities – only two hand basins on the unit"*
- *"Confusion over correct procedure re line (IV) changing"*
- *"Lack of education"*
- *"Inappropriate/unavailable equipment i.e., spillages (blood)"*

6.2.4 Suggestions for improving infection control

Two hundred and fifty-nine comments were made by 25 staff indicating how they would like to improve infection control in their unit. The majority of staff made comments relating to improving education & training and improving clinical practice, especially in relation to hand washing and raising awareness of the problems of acquired infection in the PICU. A high proportion of responses indicated that staff wanted increased input from the infection control team and the development of research based written resources to guide practice.

Section 6.2.4, Table 1: PICU staff's suggestions for improving infection control

Topic	Categories of reply	No of comments
Improving infection control	Education, teaching or study days	18
24/25 staff responded	Improving Clinical Practice	16
	Hand washing	12
	Environmental issues	10
	Policies, protocols, guidelines	8
	Increased input from infection control	7
	Audit	4
	Inter-professional comments	3
	Total number of comments	**78**
Communication of policies	Education, teaching or study days	17
24/25 staff responded	Policies, protocols, guidelines	13
	Awareness raising, visual cues	11
	Involvement of staff, ownership	8
	Increased input from infection control	7
	Audit	3
	Incorporation in care plans	2
	Miscellaneous	2
	Total number of comments	**63**
Infection control education	Education, teaching or study days	22
25/25 staff responded	Increased input from infection control	10
	Involvement of staff, ownership	10
	Policies, protocols, guidelines	7
	Awareness raising, visual cues	5
	Staff orientation programmes	5
	Audit	3
	Miscellaneous	1
	Total number of comments	**63**
Educational Topics	Microbiology and Infection Control	39
20/25 staff responded	Clinical Practice	15
	Miscellaneous	1
	Total number of comments	**55**

Improving Infection Control - detailed responses

Eighteen suggestions were made for staff education, including lectures, seminars and study days. One nurse commented *"I would like teaching on interpretation of results".* Two nurses and 1 doctor suggested that medical staff should be educated in good techniques. One nurse wanted more education for both medical and nursing staff and responded that she was *" very ignorant of infection control issues".* Sixteen comments were made about improving clinical practices, 8 relating to improving intra-vascular line insertion and care, 5 relating to improving respiratory care and endo-tracheal suctioning. One nurse wanted *"more user friendly aprons – they currently hang on coat hangers and fall on to the floor, which encourages infection spread".* Ten comments were made by staff wanting to improve environmental infection control including general cleaning of equipment. Eight comments were made suggesting written infection control guidelines, policies or protocols and 7 comments related to increasing the input of the Infection Control Team. Twelve comments relating specifically to improving handwashing.

Section 6.2.4, Table 2: Examples of suggestions for improving hand washing

- *"All personnel to wash hands when dealing with patients, especially when going to other patients"*
- *"More obvious policies on handwashing [...] varies from day-to day"*
- *"Be more assertive in encouraging other members [...] multi-disciplinary team to carry out strict hand washing and aseptic technique"*
- *"Stricter handwashing of medical staff between patients"*
- *"Better provision for washing pots [...] away from where we wash our hands after working with patients"*

Improving communication of infection control policies within the hospital

Twenty-four staff made suggestions for improving communication of infection control policies within the hospital. One doctor responded *"What policies?!"* Seventeen suggestions were made for improving staff education, 13 related to improving written guidelines, policies and protocols. Eleven suggestions were made for increasing staff awareness of the problems within the PICU, including 6 suggestions for visual cues including wall charts and notice boards, 1 nurse wanted a *" hand washing technique poster prominently displayed above each sink".*

Improving infection control education in the PICU

All 25 PICU respondents answered this section of the questionnaire. The majority of staff (22) wanted more education, study days and information about infection control with emphasis on the relevance to PICU. Twelve staff wanted mandatory study days in the staff orientation programmes and repeated continuously through staff development programmes, similar to attendance at annual fire lectures. Ten comments were made to increase the educational input from the Infection Control Team and 10 comments were made which related to PICU staff becoming more involved in this area of practice, including suggestions for PICU-based nurses with responsibility for infection control.

Suggestions for Topics within an Infection Control Education Programme for PICU

Twenty staff gave suggestions for topics that they would like to see in an infection control education programme for PICU. Thirty-nine staff wanted topics related to the basic principles of infection control, 25 staff suggested topics relating to microbiology, including *"MRSA and how to deal with it"* and *"Information on common causes of infection in PICU"*. Four staff wanted more education on research and one suggested *"mock research scenarios investigating infection control"*. Eleven suggestions were made relating to education for improving clinical practice.

Section 6.2.4, Table 3: Suggestions for educational topics relating to clinical practice

- *"More on prevention"*
- *"Hand washing"* (two suggestions)
- *"Effective barrier nursing"* (two suggestions)
- *"Universal Precautions"*
- *"Practical implications for infection control"*
- *"Correct disposal of waste"*

6.2.5 PICU Staff Attitudes to Infection Control

All 25 PICU staff members responding completed a five point Likert scale questionnaire. This was designed to reveal their attitudes towards, and perceptions, of issues relating to infection control in the PICU. All staff either disagreed or strongly disagreed with the statement *"Now that antibiotics are more available, infection control measures are less important"*, with 88% strongly disagreeing with this statement. The majority of staff 64% disagreed or strongly with the statement *"some infection control procedures are too demanding to strictly adhere to"*, but 32% agreed with this statement or were uncertain.

Now that antibiotics are more available, infection control measures are less important

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	25	0%	0%	0%	12%	88%
nurses	21	0%	0%	0%	14%	86%

Some infection control procedures are too demanding to strictly adhere to

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	25	4%	16%	16%	40%	24%
nurses	21	5%	10%	14%	43%	29%

Twenty-one staff (84%) agreed or strongly agreed that *"more training was needed for nursing staff"*, but all 25 staff agreed or strongly agreed that *"more training was needed for medical staff'.*

More training is needed for nursing staff

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	25	32%	52%	4%	12%	0%
nurse	21	38%	52%	0%	10%	0%

More training is needed for medical staff

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	25	68%	32%	0%	0%	0%
nurse	21	76%	24%	0%	0%	0%

There was considerable variation in responses to the statement *"my pre-registration infection control education/training was useful "*, 52% of staff (13/25) agreed or strongly agreed with this statement, 7 staff (28%) disagreed and 2 staff strongly disagreed (8%), 3 nurses were uncertain.

My pre-registration infection control education/training was useful

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	25	4%	48%	12%	28%	8%
nurses	21	5%	57%	14%	19%	5%

Twenty-two staff (88%) disagreed or strongly disagreed that *"hospital infection courses are only necessary for Infection Control Nurses and microbiologists"*, but 3 nurses were uncertain.

Hospital infection courses are only necessary for infection control nurses and microbiologists

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	25	0%	0%	12%	40%	48%
nurses	21	0%	0%	14%	38%	48%

All staff agreed or strongly agreed that *"it is necessary for doctors/nurses to keep up to date with current research on infection control relevant to their work"*. The majority of staff agreed or strongly agreed that *"all doctors/nurses should attend regular courses in infection control to maintain standards"*, but 2 doctors and 1 nurse were uncertain about their agreement with the statement.

It is necessary for Doctors/nurses to keep up to date with current research on infection control relevant to their work

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	25	40%	60%	0%	0%	0%
nurses	21	48%	52%	0%	0%	0%

All doctors/nurses should attend regular courses in infection control to maintain standards

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	25	32%	56%	12%	0%	0%
nurses	21	38%	57%	5%	0%	0%

In response to the statement *"infection control standards should be maintained even if staff must spend more time on each procedure"*, 88% (22/25) agreed or strongly agreed, but two nurses were uncertain and one nurse disagreed.

Infection control standards should be maintained even if staff must spend more time on each procedure

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	25	36%	52%	8%	4%	0%
nurses	21	38%	48%	10%	5%	0%

The majority of the sample disagreed or strongly disagreed that *"even if all infection control practices were performed correctly cross-infection would not be significantly reduced"*, but 5 nurses were uncertain. Sixty-eight per cent of staff disagreed or strongly disagreed that *"little can be done to further reduce cross-infection"* but 1 nurse was uncertain.

Even if all infection control practices were performed correctly, cross-infection would not be significantly reduced

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	25	0%	0%	20%	60%	20%
nurses	21	0%	0%	24%	52%	24%

Little can be done to further reduce cross-infection

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	25	0%	0%	4%	68%	28%
nurses	21	0%	0%	5%	66%	29%

All staff agreed or strongly agreed that *"hospital patients are very susceptible to cross-infection"*, but 2 nurses were uncertain about the statement, *"hospital infections cause only minor illnesses"*.

Hospital patients are very susceptible to cross-infection

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	25	52%	48%	0%	0%	0%
nurses	21	62%	38%	0%	0%	0%

Hospital infections cause only minor illnesses

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	25	0%	0%	8%	36%	56%
nurses	21	0%	0%	10%	38%	52%

Twenty-four staff disagreed or strongly disagreed that *"it is not feasible to maintain good hygiene procedures in a large hospital"*, but 1 nurse was uncertain. Eleven disagreed or strongly disagreed (44%) and thirteen were uncertain (52%) about their agreement with the statement *"the current infection control procedures in this hospital are effective"*. Only one nurse agreed with this statement.

It is not feasible to maintain good hygiene procedures in a large hospital

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	25	0%	0%	4%	28%	68%
nurses	21	0%	0%	5%	24%	71%

The current infection control procedures in this hospital are effective

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	25	0%	4%	52%	24%	20%
nurses	21	0%	5%	52%	24%	19%

Four nurses (19%) agreed that *"strict adherence to control of infection procedures is a luxury which the busy doctor or nurse can seldom afford"*, but 80% of staff (20/25) disagreed or strongly disagreed with this statement. One nurse was uncertain. There was wide variation in responses to the statement *"constant hand washing, use of aseptic technique etc., is bad for the hands"*, 11 nurses (52%) agreeing with this statement, 1 strongly agreeing and 1 nurse being uncertain. Twelve staff disagreed or strongly disagreed with this statement, including all 4 doctors.

Strict adherence to control of infection procedures is a luxury which the busy doctor or nurse can seldom afford

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	25	0%	16%	4%	52%	28%
nurses	21	0%	19%	5%	52%	24%

Constant hand washing, use of aseptic technique etc., is bad for the hands

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	25	4%	44%	4%	36%	12%
nurse	21	5%	52%	5%	29%	10%

6.3 PICU Infection Control Audit and Care Planning System

6.3.1 Introductory phase

The action research programme in infection control commenced in the PICU in January 1995, but the researcher had previously had discussions with both medical and nursing staff about the potential for improving infection control. The introductory phase of the action research in the PICU lasted five months. This was a comfortable amount of time to arrange full clinical access through the medical, nursing, infection control and patient administration teams. Ethical approval for the study was given by Chairman's action. The organisers of the Department of Health Nursing Studentship Awards (Nursing Directorate) reviewed the research proposal and study design. The introductory phase allowed the researcher to present research seminars and establish a group of volunteer nurses to support this research. The researcher also spent time formally and informally exploring roles and responsibilities within each ICU. This exploration was informed by the responses from the questionnaire surveys of ICU nurses' current knowledge and attitudes towards infection control.

6.3.2 Theoretical framework for change

Unfreezing: coming to terms with the need for change

Originally the researcher intended to act as internal change agent and become an integral member of the PICU team. This would have been followed by a planned period of researcher withdrawal with a period of post-intervention evaluation. However, in practice, this did not occur. The PICU Nurse Manager decided that one Senior Nurse would have the role of PICU research co-ordinator, internally managing the project as part of her individual performance review. The PICU research co-ordinator had not volunteered and both she and the researcher had concerns about the value of this approach. It was agreed that this was to be seen as development opportunity for the PICU research co-ordinator, but there was support from the researcher and an agreement that the Research co-ordinator could *"opt out"* if she felt she was not coping with the work. The PICU research co-ordinator was visited frequently and a satisfactory initial working relationship was established. Both researcher and the PICU research co-ordinator agreed to continue with the project. The role of the researcher was to facilitate the PICU Research co-ordinator in familiarising herself with the research literature and a resource file was provided by the researcher

which covered relevant infection control literature with specific emphasis on prevention of infection in the ICU. A series of PICU nursing staff seminars contributed to the change process by incorporating the background to the research (the problem), results of previous research (identifying potential for change) and education and information to raise awareness (providing the means for change). The research problem was presented within the context of PICU and the need for change was discussed. Desired changes were suggested and negotiated with staff. The seminars gave staff who attended feedback on the results of the staff questionnaires on infection control education, knowledge and practice. Results were used as a basis for discussion on the value of the proposed research. The researcher needed to establish that there was potential to improve the current arrangements for management, organisation and delivery of infection control and wanted to raise the awareness of nurses that they could have a central role to play in these developments. Change was to be developed within the culture of the PICU using a "bottom-up" approach. The intention was that this approach would be able to generate critical knowledge about what change could or could not be achieved in relation to infection control in the PICU. Release of nursing staff from the PICU was problematic, so the research seminars were given in the central area of the PICU during a normal shift. On reflection, this enabled staff to receive the information without being far from their patients, could come and go, but continued to hear the information. It was hoped that this also established the Researcher's credibility as someone who was comfortable in a clinical environment and was willing to adapt to staff's changing workloads.

Introducing new values

Developing ownership of the project as a whole and achieving multi-disciplinary consensus of the proposed changes was essential. A period of careful planning and negotiation continued to take place through regular meetings and the research co-ordinator established an internal team of nurse associates who became the PICU infection control quality improvement team. Independent of the researcher, but assisted by the infection control research resources, this internal team established priorities for the PICU. The PICU initially developed an information booklet for parents on infection control on the PICU and proceeded to develop an educational programme for staff.

Acceptance of new values

The next stage of the research process was to disseminate the proposed research documentation and to develop a PICU-specific, infection control, core care plan. The documentation was designed and developed to support collection and collation of infection control risk factors, process measures of care and the clinical outcome for four ICU-acquired infections. The framework for the documentation was provided by the researcher. It was developed and incorporated into local Trust-style documentation (Appendix II, Chart 2), presented in a familiar portrait style format to match other PICU documentation. The PICU research co-ordinator organised all nursing and medical staff to review this documentation and modifications were made accordingly. Members of medical team were helpful in their comments and requested specific changes to documentation of care associated with intra-vascular devices. Achieving consensus for the PICU research documentation and the PICU infection control care plan required an intense period of consultation with members of the PICU team and health professionals working outside the PICU who had responsibility for infection control.

Developing consensus

Consensus was achieved for the research documentation that included the PICU infection control care plan (Appendix II, Chart 2) and the PICU infection control risk assessment tool (Appendix II, Chart 4). The PICU infection control summary chart was incorporated after requests from medical staff made during the pilot phase (Appendix II, Chart 5).

Research documentation was supported by an introduction to the research (Appendix II, Chart 1) which was written to promote staff and parental understanding of the research; background to the research was presented as an appendix to the PICU research documentation information (Appendix II,Chart 15). Consensus for the system was achieved and this included the Trust's Professor of Microbiology reviewing the full documentation and agreeing to its use in practice. The charts were also circulated to key staff at the Central Public Health Laboratories in Colindale, London for their comments. There was general agreement that the data items covered all aspects required for the purposes of the research.

6.3.3 Developing the documentation

Site-specific infections measured in PICU

Nursing, medical and microbiology staff agreed the infection definitions and research documentation. The PICU research documentation was developed to support daily monitoring of each child's infection status, relevant interventions and outcome. Infections measured were, lower respiratory tract infections - LRTIs (Appendix II, Charts 6 and 7), blood stream infections - BSIs (Appendix II, Charts 8 and 9), surgical wound infections - SWIs (Appendix II, Charts 10 and 11), catheter-related urinary tract infections - UTIs (Appendix II, Charts 12 and 13).

A clinical outcome summary sheet was provided for all four site-specific infections being measured (Appendix II, Chart 14). Definitions for all four site-specific infections were adapted from previously published, nationally acceptable definitions that had been used for previous research studies (Appendix II, Charts 6, 8, 10 and 12). Clinical signs and symptoms for each of the four infections being measured were sub-divided into 3 or 4 stages to reflect patient infectious status.

All research interventions and infection control educational activities introduced within this study were supported and facilitated by the Researcher. All information required to conduct the prospective audit was pre-defined and coded where possible and contained within the research folder. It was agreed in the PICU that it would be feasible to pilot the system. After initial training, it was established that, if the clinical information were available, the actual time taken to complete the forms for each patient would be less than 5 minutes per day.

6.3.4 Managing bedside data collection

The documentation and charts were incorporated in a plastic folder at the bedside. Each folder had the contact name, address and telephone number of the researcher, research supervisors and external advisors to the action research. Details of the consultant with clinical responsibility for the PICU patients, the PICU Nurse Co-ordinator were provided and the code reference for ethical approval was included on the front of the folders during the pilot phase in case there were any queries about the study. Ten research folders were provided (twice the number of PICU beds), a large quantity of replacement documentation and two labelled A4

box files. One box file contained new research documentation and one box file was used to store completed research documentation.

The research co-ordinator took full responsibility for managing the documentation collection and collation. Staff were asked to complete three stages for all children admitted to PICU: infection risk assessment on admission, processes and outcomes documentation once daily and a discharge summary at the end of a child's PICU stay.

Piloting the Bedside Infection Control Care Planning and Audit

A pilot bedside collection of data commenced in June 1995 and continued to the end of September 1995. On visiting the PICU on day two of the pilot, the researcher established that there had been a successful, problem-free introduction. The researcher visited PICU frequently, but in reality was not required to manage the research. Evaluation of the pilot was continuous. Patients who had been missed were generally those who were on the PICU less than 24 hours. The pilot phase proved extremely successful and became the model for the introduction of the research in the next phase of the study.

The methodology for data collection was not changed, but the research documentation was modified slightly as a result of evaluation by nursing staff. Nursing staff at this stage wanted to collect more data items and there was a request from the PICU Medical Director to provide a summary sheet to include as a permanent record in the patient's notes. Pilot data analysis showed there was no development of infection for any child who stayed between 48 and 72 hours. It was decided that the potential success of the research could be increased without hindering the research rigor or sensitivity by adhering to more recent published definitions of acquired infections. Therefore, PICU-acquired infections were defined as those occurring more than 72 hours after admission.

Establishing Staff Satisfaction and Ownership

The general response to the audit was positive with staff identifying their own needs and setting about arranging solutions without the aid of the researcher. Infection rates at the pilot phase appeared to be low. One nurse commented *"it really raises awareness."*

The PICU Director had *"noticed that the nurses were confident in using the research documentation, but that the doctors had made one or two decisions about the infection status of children on PICU recently and would have liked to know how to use the documentation".* Following this comment a further research seminar was arranged with good attendance from the senior medical team from PICU and other paediatric departments. The PICU invested in a well-referenced book on *'Prevention and Control of Nosocomial Infections'* (Wenzel 1993). The researcher was available to support the research co-ordinator, in practice this was not necessary.

6.3.5 Retrospective audit

Retrospective data was collected by the both the researcher and the research co-ordinator in PICU from January 1994 until June 1997, the completion of the research period. The same data items were collected as for the bedside method of audit, but used clinical information recorded in the child's medical case notes.

The PICU Medical Director provided computerised data for all children who stayed longer than 24 hours on the PICU during the study period. This contained data on patient identity, age, sex, length of stay and primary diagnosis. The pathology department supplied computerised data of all swabs and specimens sent for bacteriology culture from January 1994 to December 1996. No further pathology data was available after this date.

All children who had stayed longer than 72 hours on PICU and had details of bacteriology swabs or samples sent for: sputum, blood, urine or wound-related were identified as potentially having a PICU-acquired infection. Medical case notes of these children and for children who were missed from the bedside audit were accessed and audited in two stages.

6.3.6 Data collation and analysis

For the retrospective data collection, documentation (medical notes, charts, bacteriology results, prescription sheets and discharge letters) within the child's case notes was reviewed for written evidence of possible indicators for each infection being measured. Cases with possible indicators of infection had more detailed data collection and collation. Clinical signs and symptoms of each infection

were staged and data recorded in four parameters: positive clinical signs and symptoms of infection, positive bacteriology results, antibiotic prescription and medical diagnosis were collated and stored.

Table 3 shows examples of detailed data collection for LRTI and BSI. Example no.2 with a LRTI coding of **a3(8-10)c8**, shows that purulent sputum (parameter a) was recorded on days 8 to 10 with a related antibiotic change (parameter c) on day 8. Thus the child is recorded as having acquired a LRTI on day 8. Example no.4 has a BSI coding of **a3(6-7)a4(8)b6c6d6**, shows bacteraemia (parameter a) on days 6-7 with developing septicaemia (parmeter a) on day 8, with a positive blood culture (parameter b), an associated antibiotic change (parameter c) and written medical diagnosis (parameter d) on day 6. Thus the child is recorded as having an acquired BSI on day 6.

Section 6.3.6. Table 3: Example of LRTI/BSI coding using 4 the parameters

No	LRTI (day)	LRTI coding	BSI (day)	BSI coding
1	n	a2(3)	n	
2	**y(8)**	**a3(8-10)c8**	n	
3	n	a1(2);a2(4)	n	
4	**n**		**y(6)**	**a3(6-7)a4(8)b6c6d6**
5	n	a2(0)b(0)c(0)d(0)	n	
6	n	a3(11-21)	n	
7	**y(4)**	**a2(4)a3(5-7)b4c4d4**	n	
8	**y(7)**	**a3(13)b7c7d7**	n	

Table 4 shows examples of how final outcome measurement for LRTI and BSI was recorded and stored with associated patient data and admission diagnosis. Bedside audit data were collated in the same way, but utilised the direct coding of the parameters and stages of infection undertaken by nurses at the bedside.

Section 6.3.6. Table 3: Example of LRTI and BSI coding for positive outcomes

LRTI		BSI		Sex	Stay	Age	Admission diagnosis
1	a2bcd	1	bc	M	6.3	34	Subdural haematoma
1	acd	1	bcd	F	4.1	104	Chest infection
1	a3bcd	1	a3bcd	F	15.2	104	RTA and head injury
1	a3bcd	1	a4bcd	M	4.5	231	Respiratory failure,
1	a3bd	1	bcd	M	19.8	301	Pneumonia ?RSV positive
1	bcd	1	bcd	M	20.3	306	Post operative laparotomy

6.4 PICU quantitative results

Using the SENIC methods for data analysis (Hayley *et al.* 1985) time one (T_1) year was the eighteen-month period from January 1994 to June 1995. Bedside data collection commenced in July 1995 and time two (T_2) year was the eighteen-month period from July 1995 to December 1996.

6.4.1 Admissions

From January 1994 to the end of December 1996, 808 children were admitted to the PICU.

Section 6.4.1. Table 1: All admissions to the PICU

	Jan. 94 to Jun. 95 (T_1)	Jul.95 to Dec. 1996 (T_2)
PICU admissions	331	477

6.4.2 Bacteriology sampling

Details of bacteriology samples from PICU were available in a computerised format from January 1994 to December 1996. During this period there were 808 children admitted to the PICU and there were a total of 3802 routine samples sent for bacteriology culture, of which 2256 were classified as related to this research.

Section 6.4.2. Table 2: Bacteriology samples

Intervals	Total	Respiratory	Blood	IV tip
T1	1743	413	476	161
T2	2059	456	563	187
% change (T_1 to T_2)	18.13%	10.41%	18.28%	16.15%

From T_1 to T_2 there was an 44.1% increase in numbers of children admitted to the PICU and an 18.1% increase in numbers of all bacteriology samples. Respiratory samples increased by 10.4% and blood cultures increased by 18.3%.

6.4.3 The study group

From January 1994 to December, 307 children stayed longer than 72 hours in the PICU (Appendix II, Table 1) and were identified as the study group accounting for 38% of the total number of admissions to PICU during the study period.

Section 6.4.3,Table 1: Proportion of children staying longer than 72 hours

	Jan. 94 to Jun. 95 (T_1)	Jul.95 to Dec. 1996 (T_2)
No. children	134	173
% of all admissions	40.5%	36.3%

The children staying longer than 72 hours on the PICU, had an average age of 3 years, ranging from I day to 17 years. Their average length of stay was 10 days, ranging from 3 days to 372 days. During T_1 average age for the study was 2.8 years, ranging from 2 to 5 years with an average length of stay of 11.7 days, ranging from 12 to 15 days. During T_2 average age was 3.3 years, ranging from 1 to 5 years and average length of stay was 9.9, ranging from 14 to 35 days.

Section 6.4.3, Table 2: Sex, age and length of stay for children staying >72 hours

	Jan. 94 to Jun. 95 (T_1)	Jul.95 to Dec. 1996 (T_2)
No. males	82	97
No. females	52	76
Av. stay(days)	11.7	9.9
Av. age (days)	1009	1192
Av. age (years)	2.8	3.3

PICU case-mix for children staying longer than 72 hours

Table 3 shows the admission diagnosis for all children who stayed longer than 72 hours on the PICU for the full study period.

Section 6.4.3. Table 3 Trends of admission diagnosis for children staying >72 hrs

Diagnosis	Frequency	Percent
Respiratory failure	43	14.0
Respiratory infection	92	30.0
Head injury	40	13.0
Meningococcal septicaemia	36	11.7
GI surgery	24	7.8
Infected meningitis	15	4.9
Neurology	12	3.9
Neuro-surgery	4	1.3
Septicaemia	8	2.6
Cardiothoracic surgery	3	1.0
Convulsion	10	3.3
Miscellaneous	20	6.5
Total	307	100.0

Table 4 shows the change in proportions of admission diagnoses from T_1 to T_2.

Section 6.4.3. Table 4: Trends of admission diagnosis for children staying >72 hrs

	Jan. 94 to Jun. 95 (T_1)	Jul.95 to Dec. 1996 (T_2)
Respiratory Failure	37.3%(50)	12.7% (22)
Respiratory Infection	15.7%(21)	22.3% (42)
Head Injury	11.2% (15)	14.5%(25)
Meningococcal septicaemia	6.7% (9)	15.6%(27)
Gastro-intestinal surgery	6.7% (9)	9.7% (15)
Infected meningitis	6.0% (8)	4.0% (7)
Neurology (medical)	5.2% (7)	2.9% (5)
Neurology (surgery)	(0)	1.7% (3)
Septicamia	2.2% (3)	2.9% (5)
Cardiothoracic	(0)	1.7% (3)
Convulsion	1.5%(2)	4.6% (8)
Miscellaneous (=<2 cases)	7.5% (10)	6.4% (11)

6.4.4. Bedside audit

Data collection was targeted to include all children admitted to the PICU. From the introduction of the bedside audit in June 1996 until December 1896 a total of 283 sets of research documentation were completed for 447 children admitted to the PICU. This represents a percentage *"hit-rate"* for nurses' bedside data collection for all PICU admissions of 59.3%. Further detailed evaluation focuses only on the proportion of admissions who stayed longer than 72 hours on the PICU and therefore were those at higher risk of PICU-acquired infection.From commencement of the bedside audit (T_2), a total of 173 children stayed longer then 72 hours on the PICU. Of these, a total of 138 (79.8%) were usefully included in the bedside audit completed by nursing staff.

6.4.5 Retrospective audit

Audit continued until January 1999, but eight case notes from nine PICU admission episodes were unavailable.

Section 6.4.5. Table 4: PICU audit results for children staying >72hrs.

	Jan. 94 to Jun. 95 (T_1)	Jul.95 to Dec. 1996 (T_2)
Total no patients	134	173
Bedside audit (no.)	not applicable	138
Bedside audit (%)	not applicable	79.8%
Retrospective audit	125	35
Missing records	9	0

6.4.6 PICU-acquired infection

Children affected by one or more LRTIs and/or BSIs

Numbers of surgical wound infections and urinary tract infections in the PICU were very small, (only 3 SWIs and 2 UTIs were detected during the first half of 1997). Therefore data are only presented for PICU-acquired LRTIs and BSIs.

For children staying longer than 72 hours, numbers and percentages of LRTIs and BSIs were analysed to show monthly trends (Appendix II, Table 1). Numbers of LRTIs occurring each month of the study ranged from 0 to 7, the most frequent occurring per month being 2, with a monthly incidence ranging from 0% to 54%. Numbers of BSIs occurring during each month of the stduy period ranged from 0 to 4, the most frequent number per month being 0, with a monthly incidence ranging from 0% to 31%. During the first half of 1997 there were 7 LRTIs documented in April (an incidence of 54% for all children staying in the PICU longer than over 72) and 6 documented in June (an incidence of 55% for all children staying in the PICU longer than over 72) – both rates being the highest during the full study period.

During evaluation periods T_1 and T_2, of the 307 children who stayed longer than 72 hours, 68 (21.1%) children acquired a total of 57 LRTIs (18.6%) and 25 BSIs (8.1%), which were not present on admission or developed during the first 72 hours of their stay (Appendix II, Graph 1). For all 808 PICU admissions during the study period the incidence of LRTIs was 7.1% and an incidence of BSIs of 3.1%.

Section 6.4.6. Table 1 Incidence of LRTIs and BSIs for children staying >72 hours

	Jan.94 to Jun.95 (T_1)	Jul.95 to Dec.96 (T_2)	T_1 and T_2
Study group	134	173	307
No. LRTIs	31	26	57
% LRTIs	23.1%	15.0%	18.6%
No. BSIs	9	16	25
% BSIs	6.7%	9.2%	8.1%

The PICU infection percentage for admissions staying longer than 72 hours was the estimator of the infection rate. The outcome measure for assessing the impact of the bedside audit, was the relative change of the infection rate.

$$\text{Relative change} = \frac{P_2 - P_1}{P_1}$$

where P_1 and P_2 were the infection rates at T_1 and T_2. Multiplying the relative change by 100 gave the percentage change of the infection rate from T_1 to T_2. The relative change in percentage of LRTI for children staying longer than 72 hours on the PICU from T_1 to T_2 was a reduction of 35.1% (X^2 = 3.28 on 1 df, p=0.07). The relative change in percentage of BSI for children staying longer than 72 hours on the PICU from T_1 to T_2 was an increase of 37.3%.

6.4.7 Analysis of risk

Admission diagnosis

Table I shows the distribution of LRTIs and admission diagnosis. LRTIs were most frequent in children admitted for respiratory infection, head injury, respiratory failure and gastro-intestinal surgery.

Section 6.4.7. Table 1 LRTI and Admission Diagnosis

Admission diagnosis	LRTI	%
Respiratory Infection	17	29.8%
Head injury	14	24.6%
Respiratory Failure	10	17.5%
GI surgery	8	14.0%
Miscellaneous	3	5.3%
Neuro-surgery	2	3.5%
Cardio-thoracic surgery	1	1.8%
Meningococcal septicaemia	1	1.8%
Neurology	1	1.8%

Table 2 shows the distribution of BSIs and admission diagnosis. BSIs were most frequent in children admitted for gastro-intestinal surgery, respiratory failure and head injury.

Section 6.4.7. Table 2 BSI and Admission Diagnosis

Admission diagnosis	BSI	%
GI surgery	6	24.0%
Respiratory failure	6	24.0%
Head injury	4	16.0%
Miscelllaneous	2	0.8%
Neurology	2	0.8%
Respiratory Infection	2	0.8%
Convulsion	1	0.4%
Meningococcal septicaemia	1	0.4%
Respiratory Infection	1	0.4%
Respiratory Infection	1	0.4%

Length of stay

From T_1 to T_2, the length of stay for children who stayed longer than 72 hours in PICU decreased from 11.7 days to 9.9 days, with children staying an average 2 days longer during T_1 than T_2, but variation in lengths of stay were considerable.

Section 6.4.7. Table 3 Average length of stay for children staying > 72 hr.

	Jan. 94 to Jun. 95 (T_1)	Jul.95 to Dec. 1996 (T_2)
All	11.7 days (SD 33 days)	9.9 days (SD 23 days)
LRTI only	13.7 days (SD 16 days)	29.9 days (SD 69 days) *(median stay 10.9 days)*
BSI only	15.9 days (SD 1 days)	9.7 days (SD 3 days)
LRTI and BSI	11.8 days (SD 10 days)	17 days (SD 12 days)

Average age of all children staying longer than 72 hours was 3.0 years, ranging from I day to 17 years (SD 1568 days). During T_1 average age for the study was 2.8 years, ranging from 2 to 5 years (SD 1386.1 days). During T_2 average age was 3.3 years, ranging from 1 to 5 years (SD 1695.0 days). Comparing the trends for average age of the study group before the bedside audit commenced with the period after the bedside audit commenced children who acquired both LRTIS and BSIs were considerably younger than those who acquired only LRTI or only BSI.

Section 6.4.7. Table 4: Average age for children staying longer than 72 hr.

	Jan. 94 to Jun. 95 (T_1)	Jul.95 to Dec. 1996 (T_2)
All	3.0 years (SD 1568 days)	3.3 years (SD 1695 days)
LRTI only	3.1 years (SD 1370 days)	3.9 years (SD 1960 days)
BSI only	4.3 years (SD1757 days	3.2 years (SD 1773 days)
LRTI and BSI	1.3 years (SD 359days)	2.7 years (SD 1510 days)

During the study period, T_1 and T_2, of the 57 PICU-acquired LRTIs, 56.1% (32) were acquired by boys and 43.9% (25) were acquired by girls. Of the 25 BSI acquired 68% (17) were acquired by boys and 32% (8) by girls.

6.5 PICU research development

The research study continued from June 1995 until the end of December 1996. With the encouragement of the PICU Medical Director, the internal PICU research co-ordinator prepared and presented the interim results of the research at an international medical conference. Further papers were presented by the PICU research co-ordinator at a UK national paediatric intensive care conference during 1996 and at a fringe event organised during the Royal College of Nursing Congress Meeting in 1998.

When the planned research period was complete. The PICU moved to a new, larger unit in October 1997 and during this phase, there was a brief period when no data were collected. After the move to a new PICU, the infection control audit and care planning documentation was reintroduced as routine nursing practice, with an associated education programme conducted by the internal research co-ordinator and a PICU infection control team. The documentation then continued as originally designed until 1998, but data were only collected for LRTIs and BSIs. At this point the PICU research co-ordinator asked the researcher to send a modified version of the documentation, (similar in design to the GITU version). This involved risk assessment for all children admitted to the PICU but only audit of LRTIs and BSIs for all children who stayed on the unit for longer than 72 hours. This modified version of the documentation was introduced and data collection has continued as routine practice, internally managed by the PICU staff independent of the researcher. The PICU-acquired infection study is now completely owned and managed by the PICU, the researcher having moved to a post of Research Fellow in Children's Nursing.

6.6 PICU research and development plans

In 1998, the PICU research co-ordinator was successful in gaining the position managing and co-ordinating a national UK drugs trial relating to meningococcal infection. The PICU has now agreed to act as a second site, piloting routine risk assessment and outcome monitoring for a study investigating pressure damage acquired by children requiring intensive care. The model and design for the pressure damage study and its project planning has been the PICU-acquired infection study. The pressure area study is being co-ordinated by a different PICU senior sister and will be conducted in four sites - two PICUs and a centre for paediatric respite care.

6.7 The GITU profile

GITU was ten-bedded unit that was funded to have seven beds open, the bed numbers changed to seven beds in November 1996. There were two side rooms for isolation purposes. Average bed occupancy in 1994/5 was 63%; in 1995/6 was 74% and 1996/7 was 69%. Average length of GITU patient stay in 1994/5 was 4.0 days; in 1995/6 was 5.0 days and 1996/7 was 4.3 days. Total numbers of admissions to the GITU in 1994/5 were 306; in 1995/6 were 343 and in 1996/7 were 403. During 1994/5 85% of patients were admitted as emergencies and numbers of patients requiring ventilation in 1994/5 was 72%.

There was an of average 7-8 nurses on duty on each shift with a nurse to patient ratio of at least 1:1 with an additional nurse in charge. The GITU had total of 49 nursing staff. This unit had a nursing induction programme; for the first nine weeks staff were supernumerary followed by a period of clinical supervision. Nurses promoted to E grade had to have 18 months experience of GITU and an approved ENB ICU course. 28 nurses had the ENB course. In 1998, the GITU was successful in achieving an "Investors in People" award. A large component of the application for this award rests upon plans for staff training and development.

The ICU Director who was a Consultant Anaesthetist with a second deputy Consultant Anaesthetist on the GITU team. Both consultants had other responsibilities in theatres. Other medical staff included mixed specialities with sessional and on-call responsibilities, including consultants, senior registrars and registrars who all had some input to the GITU depending on patient need.

All infection control protocols used in GITU were unit specific and the unit had a detailed comprehensive district wide infection control policy file that was kept in the main GITU area. There were written policies relating to control of infection for endo-tracheal suctioning; all aspects of urinary catheter care and surgical wound care, except for agents to clean to wound which was a verbal policy. Other verbal policies were in place for: insertion and care of all intra-vascular devices and lines; time to change ventilator tubing and terminal cleaning of ventilators. There were only two hand basin in the main GITU area, the minimum distance from a bed space to hand basin was less than one metre and the maximum was 8 metres.

6.8 GITU Questionnaire Responses

6.8.1 Infection control education, knowledge and practice

There were a total of 26 questionnaire responses from two doctors and 24 nurses. In the sample of doctors responding, one was a Senior Registrar and one was a Registrar. The response rate from registered nursing staff was 49% (24/49) with responses from four G grade nurses, six F grade nurses, nine E grade nurses and five D grade nurse[2].

Reading and understanding bacteriology reports

Ninety-six percent of staff (25/26) responded that they always or sometimes read bacteriology reports, with 73% responding sometimes (19/26). Only 8% of staff thought they always understood bacteriology results. One of the two doctors responded always reading bacteriology and always understanding bacteriology culture reports. The other doctor sometimes read bacteriology reports and sometimes understood them.

Five nurses always read the reports, eighteen nurses reported sometimes reading them and one nurse (an F grade) rarely read them. No nurses reported never reading the reports. Only one nurse (E grade) responded that she always understood bacteriology reports. The majority of nurses, 83% sometimes understood them (19/23) and three nurses rarely understood bacteriology reports.

Do you always read bacteriology reports?

Responses	n	Always	Sometimes	Rarely	Never
all	26	23%	73%	4%	0%
nurses	24	21%	75%	4%	0%

Do you always understand bacteriology reports?

Responses	n	Always	Sometimes	Rarely	Never
all	25	8%	80%	12%	0%
nurses	23	4%	83%	13%	0%

[2] The sample size from the questionnaire responses was small - percentages have been used rounded up to whole numbers for ease of reading rather than for mathematical accuracy.Therefore responses do not total 100%

Incorporating results of bacteriology reports into care plans

Thirty-two percent (8/25) of all staff reported that they always incorporated bacteriology results in the patient's care plan, with 48% (12/25) doing so sometimes. One doctor always incorporated bacteriology results, with the other doctor doing so sometimes. Five nurses rarely incorporated bacteriology results into care plans.

Do you incorporate the results of bacteriology reports into patient care?

Responses	n	Always	Sometimes	Rarely	Never
all	25	32%	48%	20%	0%
nurses	23	30%	48%	22%	0%

Assessing and documenting patient risk of acquiring an infection in hospital

Eighty-five percent of all staff (22/26) responded that they always or sometimes assessed risks, but only four of 22 nurses responding reported always documenting the patients' risks of acquiring infection. One doctor always assessed patient risks with the other assessing risks sometimes, but neither doctor documented these risks. Four nurses (18%) reported sometimes documenting risks, 9 rarely (41%) rarely and five nurses (23%) reported never documenting the patients' risks of acquiring an infection.

Do you routinely assess your patients' risks of acquiring an infection in hospital?

Responses	n	Always	Sometimes	Rarely	Never
all	26	65%	19%	15%	0%
nurses	24	67%	17%	17%	0%

Do you document your patients' risks of acquiring infection?

Responses	n	Always	Sometimes	Rarely	Never
all	24	17%	17%	42%	25%
nurses	22	18%	18%	41%	23%

Documenting the presence of a hospital-acquired infection

Eight nurses (8/24) responded that they always documented the presence of an acquired infection and eight nurses and one doctor responded that they sometimes did so. Twenty-one percent of nurses (5/24) rarely recorded this information and one doctor and three nurses never recorded the presence of a hospital-acquired infection.

Do you document the presence of a hospital-acquired infection?

Responses	n	Always	Sometimes	Rarely	Never
all	*26*	31%	35%	19%	15%
nurses	24	33%	33%	21%	13%

Adequate planning and delivering care aimed at reducing risk

Fifty percent (13/26) of staff responded that thought they always adequately planned and delivered care to reduce risks, with 50% (13/26) including the two doctors, considering they did sometimes. Forty-two percent (11/26) always documented this care, 46% (12/26) sometimes, including the two doctors, two rarely and one nurse reporting never documenting this aspect of care.

Do you consider you adequately plan and deliver care that aims to reduce the risk of your patient acquiring an infection?

Responses	n	Always	Sometimes	Rarely	Never
all	*26*	50%	50%	0%	0%
nurses	24	54%	46%	0%	0%

Do you document care that aims to reduce the risk of your patient acquiring infection?

Responses	n	Always	Sometimes	Rarely	Never
all	*26*	42%	46%	8%	4%
nurses	24	46%	42%	8%	4%

Knowledge of infection control and pre- and post registration education

Two doctors and eight nurses, 38% of the sample of 26 staff responding, felt that their knowledge of microbiology and infection control was adequate for prevention of infection in patients requiring intensive care and 31% (8/26) did not. Thirty-one percent of respondents (8/26) didn't know. Only 1 doctor and 2 nurses felt their pre-registration education/training for infection control provided sufficient knowledge for effective infection control in practice. One doctor and 22 nurses, a total of 88% (23/26) of respondents felt their pre-registration education/training for infection control did not provide sufficient knowledge for effective infection control in practice. Seventy-five percent of nurses (18/24) had had the opportunity to gain further knowledge in infection control since basic pre-registration training.

Do you think your knowledge of microbiology and infection control is adequate the for prevention of infection in patients requiring intensive care?

Responses	n	Yes	No	Don't know
all	26	38%	31%	31%
nurses	24	33%	33%	33%

Do you consider your pre-registration education/training for infection control provided sufficient knowledge for effective infection control in practice?

Responses	n	Yes	No	Don't know
all	26	12%	88%	0%
nurses	24	8%	92%	0%

Have you had the opportunity to gain further knowledge in infection control since your basic pre-registration training?

Responses	n	Yes	No
all	26	69%	31%
nurses	24	75%	25%

Only one of the respondents had ever taught microbiology or infection control. Twenty-seven percent of all staff (7/26) felt they could teach basic microbiology and infection control, but 73% of respondents (19/26), including the 2 doctors, felt they could not.

Have you ever taught microbiology or infection control?

Responses	n	Yes	No
all	26	4%	96%
nurses	24	4%	96%

Could you teach basic microbiology or infection control?

Responses	n	Yes	No
all	26	27%	73%
nurses	24	29%	71%

Identifying potential for change

Sixty percent of all respondents (15/25) felt that there was a need to change the approach to infection control in the GITU and 88% (23/26) thought that there was potential for change to improve infection control practices.

Do you think there is need for change in approach to infection control in the ICU?

Responses	n	Yes	No	Don't know
all	25	60%	8%	32%
nurses	23	65%	9%	26%

Do you think there is potential for improving infection control practices?

Responses	n	Yes	No	Don't know
all	26	88%	4%	8%
nurses	24	92%	4%	4%

6.8.2 Hand hygiene practices and knowledge of policies

Because the number of doctors responding to this section of the questionnaire was small, analysis of GITU hand hygiene practices is restricted to nurses' responses. With the exception of one nurse, all nurses conducted some type of hand hygiene before and after each of the five clinical procedures: routine IV line change; endo-tracheal tube suction; surgical wound dressing; emptying urinary catheter drainage bags and oral hygiene. One nurse did not use hand wash or use alcohol rub before emptying urinary drainage catheter bags (but wore non-sterile gloves for this procedure) or hand wash or use alcohol rub after surgical wound dressing.

Routine intra-vascular (IV) line change

There was a verbal policy for insertion and care of all intra-vascular devices and lines. Only one respondent correctly thought the policy was verbal. Sixteen of the 20 nursing staff who replied (80%) thought the policy for routine IV line care was written, both doctors and 3 nurses did not know what type of policy. No respondents thought there was no policy for this procedure.

Section 6.8.2. Table 1: GITU nurses' hand hygiene practice

Routine IV change		Hand hygiene	N	n	% response
	before	Hand wash only	23	9	39%
		Alcohol rub only		0	0%
		Hand wash & alcohol		14	61%
	during	Sterile gloves	22	4	18%
		Non-sterile gloves		10	45%
		None		8	36%
	after	Hand wash only	23	22	96%
		Alcohol rub only		0	0%
		Hand wash & alcohol		1	4%
GITU verbal policy		Written	20	16	80%
		Verbal		1	5%
		None		0	0%
		Don't know		3	15%

Endo-tracheal (ET) tube suction

There was a written policy for ET suctioning, 15 of 19 nursing staff responding correctly thought it was written, 2 thought it was verbal, no one thought there was no unit policy, but 2 nurses did not know what type of policy there was.

Section 6.8.2. Table 2: GITU nurses' hand hygiene practice

ET tube suctioning		Hand hygiene	N	n	% response
	before	Hand wash only	22	16	73%
		Alcohol rub only		3	14%
		Hand wash & alcohol		3	14%
	during	Sterile gloves	21	15	71%
		Non-sterile gloves		2	10%
		None		4	19%
	after	Hand wash only	22	19	86%
		Alcohol rub only		0	0%
		Hand wash & alcohol		3	14%
GITU written policy		Written	19	15	79%
		Verbal		2	11%
		None		0	0%
		Don't know		2	11%

Surgical wound dressing

There was a written policy relating to infection control for this practice, 9 nurses of 20 replying correctly thought there was a written policy, 2 nurses thought it was a verbal policy, 1 thought there was no policy, and 8 did not know.

Section 6.8.2.Table 3: GITU nurses' hand hygiene practice

Wound dressing		Hand hygiene	N	n	% response
	Before	Hand wash only	23	8	35%
		Alcohol rub only		0	0%
		Hand wash & alcohol		15	65%
	During	Sterile gloves	23	20	87%
		Non-sterile gloves		2	9%
		None		1	4%
	After	Hand wash only	22	15	68%
		Alcohol rub only		0	0%
		Hand wash & alcohol		7	32%
GITU written policy		Written	20	9	45%
		Verbal		2	10%
		None		1	5%
		Don't know		8	40%

Urinary drainage bag emptying

There was a written unit policy for this practice, 11 nurses thought there was a written policy for this practice, 2 nurses thought it was verbal, 2 thought there was no policy and 5 did not know what type of policy there was.

Section 6.8.2. Table 4: GITU nurses' hand hygiene practice

Emptying urinary drainage bag		Hand hygiene	N	n	% response
	before	Hand wash only	22	20	91%
		Alcohol rub only		2	9%
		Hand wash & alcohol		0	0%
	during	Sterile gloves	23	2	9%
		Non-sterile gloves		21	91%
		None		0	0%
	after	Hand wash only	23	18	78%
		Alcohol rub only		1	4%
		Hand wash & alcohol		4	17%
GITU written policy		Written	20	11	55%
		Verbal		2	10%
		None		2	10%
		Don't know		5	25%

Patients' oral hygiene

There was no unit policy for this practice, 13 nurses thought there was a written unit policy for this practice, no nurses thought it was verbal or did not think there was any type of policy, but 5 did not know what type of policy there was.

Section 6.8.2. Table 5: GITU nurses' hand hygiene practice

Oral hygiene		Hand hygiene	N	n	% response
	before	Hand wash only	23	18	78%
		Alcohol rub only		3	13%
		Hand wash & alcohol		2	9%
	during	Sterile gloves	22	0	0%
		Non-sterile gloves		21	95%
		None		1	5%
	after	Hand wash only	23	19	83%
		Alcohol rub only		1	4%
		Hand wash & alcohol		3	13%
No GITU policy		Written	18	13	72%
		Verbal		0	0%
		None		0	0%
		Don't know		5	28%

6.8.3 Nurses compliance with recommended hand hygiene

GITU staff were asked to indicate, from a pre-defined list, why they thought research indicates that health professional have poor compliance with recommended infection control practices. The majority (80%) indicated they thought it was due to *"shortage of time"* (22/25), 80% indicated *"confusion over correct procedures"* (20/25), 76% thought it was due to *"forgetting"* (19/25), and *"poor hand washing facilities"* was indicated by 24% (6/25) of the respondents. One doctor and three nurses indicated that it was *"not always necessary"*.

6.8.4 GITU nurses' suggestions for improving Infection Control

All 26 staff made suggestions for how they would like to improve various topics relating to infection control in the GITU. In total 189 suggestions were made. In common with the PICU, suggestions related to improving education and training, improving clinical practice and raising awareness of the staff to GITU-acquired infection. Again in common with the PICU, the GITU responses indicated that staff wanted more input from the infection control team and for research based written resources to guide practice.

Section 6.8.4. Table I GITU suggestions to improve infection control

Topic	Categories of reply	No of comments
Improving infection control 22/26 staff responded	Education, teaching or study days	17
	Improving Clinical Practice	12
	Hand washing	8
	Awareness raising, visual cues	5
	Increased input from infection control	3
	Written policies, protocols, guidelines	2
	Research clinical practice	2
	Miscellaneous	3
	Total number of comments	**51**
Communication of policies 19/26 staff responded	Education, teaching or study days	15
	Policies, protocols, guidelines	7
	Increased input from infection control	6
	Written policies, protocols, guidelines	4
	Involvement of staff, ownership	4
	Awareness raising, visual cues	3
	Research	3
	Improved documentation (care plans)	2
	Total number of comments	**44**
Infection control education 19/26 staff responded	Education, teaching or study days	21
	Increased input from infection control	5
	Involvement of staff, ownership	4
	Improved communication	3
	Staff orientation programmes	2
	Research	2
	Improved documentation	2
	Improved clinical practice	2
	Total number of comments	**43**
Educational Topics 21/26 staff responded	Microbiology and Infection Control	39
	Clinical Practice	18
	Total number of comments	**57**

Improving Infection Control - Detailed responses from GITU

Twenty-two of the twenty-six staff responding to the questionnaire gave suggestions for improving infection control in paediatric ICUs. Seventeen suggestions were made relating to staff education, including lectures, seminars and study days. One nurse commented, *"all staff to have more basic infection control knowledge"*, five nurses and one doctor suggested more education for doctors. One nurse wanted *"better training for the multi-disciplinary team"*, one wanted *"doctors to adhere to techniques"* and another one hoped for *"adherence to existing policies by all multi-disciplinary team"*. Eleven comments were made about improving clinical practices, two relating to barrier nursing *"better facilities for barrier nursing"*, one to the use of universal precautions, two to gown wearing and one suggested a *"colour coded apron for each bed space"*. Eight comments were made relating specifically to improving hand washing.

Section 6.8.4. Table 2: suggestions made by GITU staff for improving hand washing

- *"Hand washing after every procedure"*
- *"Less irritant hand wash"*
- *"Less irritant gloves"*
- *"Ensuring visiting health professionals wash hands and wear aprons"*
- *"Hand basin at every bed space" "Sink by bedside"*
- *"Better hand washing facilities i.e. taps that can be turned off without using hands"*
- *Wear gloves when dealing with ventilator tubing and changing nebulisers"*

Five staff wanted more awareness raising and visual cues, *"notices to remind people"*. Two comments were made about improving environmental infection control including general cleaning of equipment, *"more appropriate cleaning and storage of some pieces of re-usable equipment"*. Other comments included written guidance, increasing input from the infection control team, having an infection control nurse for ICU and, *"at busy times – more staff"*.

Improving communication of infection control policies within the hospital

Nineteen staff made suggestions for improving communication of infection control policies within the hospital. Fifteen suggestions were made for improving staff education, 7 respondents suggested improving methods of written and verbal communication including team meetings and bulletin sheets. Six staff wanted more involvement of the Infection Control Team and 4 suggestions were made relating to

improving written guidelines, policies and protocols for infection control. Suggestions were made for increasing staff awareness of the problems of infection control within the GITU. Four suggestions including having more involvement of GITU staff, *"Infection Control nurse for ICU"*, three for visual cues including wall charts and notice boards, three nurses wanted more information about research, *"Research –makes people aware of their practices"*.

Improving infection control education in the GITU

Nineteen staff responded to this section of the questionnaire and responses were similar to those from the PICU. Twenty-one comments were made relating to staff wanting more education, study days and information about infection control. Seven staff wanted mandatory study days in the staff orientation programmes and continuously through staff development programmes. Five suggestions were made to increase the input from the Infection Control Team, and four comments were made which related to staff becoming more involved in this area of practice, including two suggestions for ICU based nurses responsible for infection control.

Suggestions for Topics within an Infection Control Education Programme for GITU

Twenty-one staff gave suggestions for topics that they would like to see in an infection control education programme for GITU. Thirty-nine suggestions were made that related to the education in basic principles of infection control, with twenty-six suggestions relating to microbiology.

Section 6.8.4. Table 3: suggestions made for improving infection control education

- *"MRSA!"*
- *"How hospital-acquired infections occur",*
- *"How infections are spread",*
- *"How to control infection"*
- *"Basic infection control, hand washing and cleaning equipment "*
- *"Sources of cross-infection"*

Seven nurses wanted more education on how antimicrobial agents worked, and 18 suggestions were made relating to education for improving clinical practice.

Section 6.8.4. Table 4: suggestions for improving infection control practices

- *"Requirements for barrier nursing"*
- *"MRSA - confusion (over) whether cubicle door has to be open or closed"*
- *"Damp dusting and cleaning of equipment"*
- *"Aseptic techniques" "Universal Precautions and their significance"*
- *Dealing with body fluids/spillages"*

6.8.5 Attitudes to infection control

All 26 GITU members completed the five point Likert scale questionnaire used in the PICU staff survey. Ninety-six percent of staff (25/26) either disagreed or strongly disagreed with the statement *"Now that antibiotics are more available, infection control measures are less important"*, but one nurse strongly agreed with this statement. The majority of staff 73% (19/26) either disagreed (42%) or strongly disagreed (31%) with the statement *"some infection control procedures are too demanding to strictly adhere to"*, four staff were uncertain and three staff agreed with this statement.

Now that antibiotics are more available, infection control measures are less important

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	26	4%	0%	0%	12%	85%
nurses	25	4%	0%	0%	13%	83%

Some infection control procedures are too demanding to strictly adhere to

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	26	0%	12%	15%	42%	31%
nurses	24	0%	13%	17%	42%	29%

Twenty-five staff (96%) agreed or strongly agreed that more training was needed for nurses, but one doctor was uncertain. Twenty-five staff agreed or strongly agreed that more training was needed for medical staff, again one doctor was uncertain.

More training is needed for nursing staff

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	26	62%	35%	4%	0%	0%
nurses	24	63%	38%	0%	0%	0%

More training is needed for medical staff

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	26	85%	12%	4%	0%	0%
nurses	24	88%	13%	0%	0%	0%

There was wider variation in responses to the statement *"my pre-registration infection control education/training was useful "*, with only 7 staff (27%) agreeing with the statement. Nine staff (35%) disagreed and 4 staff strongly disagreed (15%), 6 of the sample were uncertain (23%).

My pre-registration infection control education/training was useful

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	26	0%	27%	23%	35%	15%
nurse	24	0%	25%	21%	38%	17%

Twenty-five staff (96%) disagreed or strongly disagreed that *"hospital infection courses are only necessary for Infection Control Nurses and microbiologists"*, no one agreed or strongly agreed with this statement, but one nurse was uncertain.

Hospital infection courses are only necessary for infection control nurses and microbiologists

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	*26*	0%	0%	4%	38%	58%
nurse	*24*	0%	0%	4%	42%	54%

Twenty-four (92%) staff agreed or strongly agreed that *"it is necessary for doctors/nurses to keep up to date with current research on infection control relevant to their work"*, one nurse was uncertain and one disagreed. The majority of staff (81%) agreed or strongly agreed that *"all doctors/nurses should attend regular courses in infection control to maintain standards"*, but four staff were uncertain and one nurse disagreed.

It is necessary for doctors and nurses to keep up to date with current research on infection control relevant to their work

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	26	50%	42%	4%	4%	0%
nurse	24	50%	46%	4%	0%	0%

All doctors and nurses should attend regular courses in infection control to maintain standards

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	26	31%	50%	15%	4%	0%
nurse	24	33%	50%	17%	0%	0%

In response to the statement *"infection control standards should be maintained even if staff must spend more time on each procedure"*, 92% (24/26) agreed or strongly agreed, but two nurses were uncertain.

Infection Control standards should be maintained even if staff must spend more time on each procedure

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	26	54%	38%	8%	0%	0%
nurse	24	54%	38%	8%	0%	0%

The majority of the sample, 81% disagreed or strongly disagreed that *"even if all infection control practices were performed correctly cross-infection would not be significantly reduced"*, but four staff were uncertain and one nurse agreed. Twenty-five staff, 96%, disagreed or strongly disagreed that *"little can be done to further reduce cross-infection"*, but one nurse was uncertain.

Even if all infection control practices were performed correctly, cross-infection would not be significantly reduced

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	26	0%	4%	15%	58%	23%
nurse	24	0%	4%	17%	54%	25%

Little can be done to further reduce cross-infection

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	26	0%	0%	4%	65%	31%
nurse	24	0%	0%	4%	63%	33%

All staff agreed or strongly agreed that, *"hospital patients are very susceptible to cross-infection"*, and all staff disagreed or strongly disagreed with the statement, *"hospital infections cause only minor illnesses"*.

Hospital patients are very susceptible to cross-infection

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	26	50%	50%	0%	0%	0%
nurse	24	50%	50%	0%	0%	0%

Hospital infections cause only minor illnesses

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	26	0%	0%	0%	23%	77%
nurse	24	0%	0%	0%	25%	75%

All 26 staff disagreed or strongly disagreed that *"it is not feasible to maintain good hygiene procedures in a large hospital".* In response to the statement *"the current infection control procedures in this hospital are effective",* five staff disagreed, and 56% were uncertain (14/25). Five staff agreed and one staff nurse strongly agreed with this statement.

It is not feasible to maintain good hygiene procedures in a large hospital

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	26	0%	0%	0%	15%	85%
nurse	24	0%	0%	0%	17%	83%

The current infection control procedures in this hospital are effective

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	25	4%	20%	56%	20%	0%
nurse	23	4%	22%	61%	13%	0%

All staff responding either disagreed or strongly disagreed that *"strict adherence to control of infection procedures is a luxury which the busy doctor or nurse can seldom afford".* There was wide variation in responses to the statement *"constant hand washing, use of aseptic technique etc., is bad for the hands",* two nurses and one doctor strongly agreeing (12%), six nurses and one doctor agreeing (27%) with this statement; seven were uncertain. Three staff disagreed (12%) and six nurses strongly disagreed with this statement.

Strict adherence to control of infection procedures is a luxury which the busy doctor/nurse can seldom afford

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	25	0%	0%	0%	52%	48%
nurse	23	0%	0%	0%	48%	52%

Constant hand washing, use of aseptic technique etc., is bad for the hands

Responses	n	Strongly Agree	Agree	Uncertain	Disagree	Strongly disagree
all	26	12%	27%	27%	12%	23%
nurse	24	8%	25%	29%	13%	25%

6.9 GITU Infection Control Care Planning and Audit System

6.9.1 Introductory stage

Initial access to the GITU was obtained by inviting the Infection Control Doctor and the Infection Control Nurse from the Trust to a University of Sheffield post-graduate seminar given by the researcher in September 1995. At this point the Infection Control Team agreed to give their support to the action research programme. The introductory stage of the research in GITU lasted 6 months, from December 1995 to May 1996. Initial contact with the GITU was through the Senior Nurse Manager who arranged for a small group of senior sisters to attend a research seminar and to consider whether to proceed with the research programme in the GITU. After this seminar it was decided to present the research to the rest of the senior team for a collective decision to be made about progressing with the research in their unit. Whilst the researcher thought that full agreement and clinical access had been arranged with all members of the Clinical Management Team, one consultant was overlooked. This posed problems later in the study when authorisation for access to medical records required this individual's permission. This problem was quickly resolved by writing to the consultant in question and making a follow-up telephone call. This resulted in full permission for access being given. Ethical approval was given a result of a full submission to the Ethical Committee of the Trust.

6.9.2 Theoretical framework for change

The management of the research programme was different in the GITU as compared with the PICU, but the researcher continued to use the theoretical framework of Action Research and Lewin's theory of change adopted to facilitate changes in the PICU. In contrast to the PICU, the researcher had no previous contact with the GITU, but there was a strong management team with proactive support and encouragement of staff development, education and practice developments.

Unfreezing: coming to terms with the need for change

There was a system for routine bacteriology sampling of patients three times per week and there was an infection control link nurse established on the GITU. This nurse has already undertaken an Infection Control course and it was usual for nurses to be sent on this course as part of their professional development. Although the infection control link nurses left the GITU during this study, there was a replacement infection control link nurses ensuring continuity throughout the research programme. In addition, a

charge nurse from GITU had been seconded to the Infection Control Team and there was a positive attitude to Infection Control from most members of the GITU team. It was accepted that the Infection Team was over-worked and that an additional resource in the GITU was welcomed. As a result of information gathering on the GITU, the researcher decided, primarily because of the differing nature of work in the GITU to that in the PICU, that rather than having a GITU research Co-ordinator who was responsible for the research, the researcher would maintain a high profile in the GITU. The researcher was well supported by the Infection Control Link Nurse, the Senior Sisters, Nursing Team and the Nurse Manager on the GITU. The Infection Control Team and staff from the Pathology Department were encouraging towards the research and were willing to review the research protocol and provide the computerised pathology data. Five introductory research seminars were presented from January 1996 to March 1996 giving background to the research and presented the results of the questionnaires.

Introducing new values

The GITU was a much larger unit than the PICU. Early discussions about the potential of the Action Research programme being introduced in the GITU included demonstrating the PICU research documentation. Despite the positive attitude of GITU nurses to infection control and an apparent recognition of the importance for nursing practice, there was concern from senior nurses about GITU nurses at the bedside having to complete more *"paperwork"*. Nurses already recorded bacteriology results on a single communication sheet in the patient's case notes, but there was no information about infection rates in the GITU. This one factor, the opportunity to measure GITU-acquired infection seemed to be the convincing element to developing acceptance of the research programme. Nurses were to give their time to test and evaluate the research documentation. The research was promoted as an opportunity to explore whether the research evidence, derived from outside the UK, could be implemented and shown to be effective in this country. Again, with many nurses involved in their own further education, there were many opportunities to promote the Action Research programme as an educational opportunity for nurses, regardless of the final outcome.

Acceptance of new values

An internal infection control team was set up to support the research and to aid research communication. The researcher maintained responsibility for the

administration of the research, and was given valuable assistance by the GITU team in organising the educational seminars, in encouraging staff to attend seminars and actively promoting the completion of the bedside research documentation. An important difference in the GITU compared to the PICU was that the series of educational seminars gave the researcher greater exposure to larger numbers of GITU staff. The seminars also ensured that all nurses were made aware, not only of the research programme, but regardng the role and responsibility of nurses in preventing infection.

Developing consensus

Because of the concerns expressed about GITU workloads and the potential additional "paperwork" involved in the PICU-style research documentation, the development of the documentation differed from that on PICU. In the GITU it was acknowledged that nurses would not be motivated to go through a series of documentation, so a modified version was redesigned and developed within a limited number of pages. This contained all the essential stages and elements recognised in the research protocol. Again an intense period of work was needed by the Researcher to develop GITU-specific infection control care plan (Appendix III, Chart 2) and the GITU infection control risk assessment tool (Appendix III, Chart 3). The documentation was supported by research information (Appendix III, Chart 1), and documentation was developed to support collection and collation of infection risk factors, process measures of care on a summry chart (Appendix III, Chart 4) and clinical outcome for four GITU-acquired infections (Appendix III, Chart 5). An infection control communication sheet was provided (Appendix III, Chart 6) for additional comments by nursing staff. A copy of the documentation was displayed on the staff notice board and everyone was asked to consider this and make comments. Consensus for the system was achieved and this included the Infection Control Doctor reviewing the full documentation and agreeing to its use in practice. There was general consensus that the data items covered all items required for effective infection control.

6.9.3 Developing the documentation

Site-specific Infections measured in GITU

Infections measured in GITU were, lower respiratory tract infections - LRTIs, blood stream infections - BSIs, catheter-related urinary tract infections - UTIs and surgical wound infections - SWIs. For each infection clinical signs and symptoms were sub-divided into 3 or 4 stages to reflect patient infectious status (Appendix III, Charts 7 and 8). A GITU-acquired infection was defined as one occurring more than 72 hours post-admission.

6.9.4 Managing bedside data collection

A system was agreed for GITU data collection and collation of results and followed the steps taken in the PICU.

Piloting the Bedside Infection Control Care Planning and Audit

Bedside collection of data commenced in June 1996. The methodology for data collection was not changed from original plans, but the research documentation was modified slightly as a result of pilot evaluation by nursing staff. Changes were made to the risk assessment process chart and the communication page was added after the pilot.

Establishing Staff Satisfaction and Ownership

The general response to the audit was positive; staff made comments such as, *"we feel involved"* and that the Researcher was "not *just a voice on the end of the telephone".* There was some resistance to increasing the amount of documentation, which was difficult to quantify, but the Researcher endeavoured to be available for nurses who were having difficulty in completing the forms. Completion of the audit documentation revealed a problem with communication in the GITU, nurses did not know the results of cultures until they were filing the paper records, but a Microbiologist visited the GITU every morning to verbally report the results. Nurses realised they were being missed from this aspect of communication, they were not normally included in this process, usually between the medical microbiologist and the GITU doctor. Some nurses acted to make sure they were included in the feedback of results, but this remained problematic, the Researcher asked for the daily print-outs from the microbiology laboratory to be left and filed on GITU, but did not become routine practice.

6.9.5 Retrospective audit

The Medical Director provided computerised data for all admissions who stayed on the GITU from January 1994 to May 1997. The Pathology Department supplied data of all swabs and specimens sent for bacteriology culture from January 1994 to May 1996. In contrast to the PICU pathology data, this data also included quantitative results of the bacteriology culture. All patients who stayed longer than 72 hours on GITU and had positive bacteriology cultures which were associated with the four ICU-acquired infections being measured (sputum, blood, urine or wound-related samples) were identified as potentially GITU-acquired infections. Medical case notes for all these patients were requested, accessed and audited. In the final analysis patients with primary diagnosis of burns, plastic surgery or pancreatitis were excluded from the study. In previous research studies, access to research case notes ion the available time for review was problematic, routine hospital activity takes precedence over research activities, therefore the researcher made special arrangements which included paying for a medical records clerk to access research case notes on an over-time basis. This arrangement also relied upon the goodwill of the Medical Records Staff and worked well.

6.9.6 Data collation and management

Followed the methods used in the PICU as described in section 6.3.6

6.10 GITU quantitative results

6.10.1 Admissions and casemix

Using the SENIC approach to data analysis (Hayley *et.al.* 1985) time one (T_1) was twelve-month period from July 1995 to June 1996. Bedside data collection commenced in July 1996 and time two (T_2) was the eleven-month period from July 1996 to May 1997. From July 1995 to the end of May 1997 758 admissions were admitted to the GITU. Exclusions from the study were 9 admissions who were less than 17 years of age, 26 patients were admitted for burns and 13 patients were admitted for pancreatitis. Only date of birth was available as a means of calculating age. Age of admissions was calculated from date of birth and admission date (dates were converted to month-year format and date of birth was subtracted from date of admission and divided by 365 as calculated on Excel©. Dates of birth of the same year of admission were excluded and in total 8 records had errors when recording the date of birth. Of the remaining 710 adult admissions, average age was 59 years (SD 17 years) ranging from 17 to 94 years and average length of stay was 4.9 days (117.4 hours) ranging from 1 hour to 82 days. There were 438 males (61.7%) and 272 (38.3%) females.

Section 6.10.1. Table 1: Summary data of all admissions to GITU

	Jul. 1995 to June 1996 (T_1)	July 1996 to May 1997 (T_2)
Admissions	326 (12 months)	384 (11 months)
Average age (years)	60	59
SD age (years)	17	17
Males	190	248
Females	136	136
Average stay (hours)	116.7	118.6
Average stay (days)	4.9	4.9
SD stay (days)	3.6	8.5
Deaths	88	100

GITU case-mix

Data from the computerised GITU database was analysed to show primary reason for all admissions. The majority of GITU admissions were post-surgical cases (46.2%) followed by patients admitted with respiratory failure (11.1%), cardiac failure (6.8%), trauma (6.5%), septicaemia 5.1%, patients with overdose (4.4%) and infective cases (3.9%).

Section 6.10.1.Table 2: Casemix analysis for all GITU admissions (n=701)

Admissions Diagnosis	%	n
Post-surgical (all)	46.2%	328
Respiratory failure including asthma (all)	11.1%	79
Cardiac failure (all)	6.8%	48
Trauma (all)	6.5%	46
Septicaemia	5.1%	36
Overdose	4.4%	31
Infective (not septicaemia)	3.9%	28
Head injury	2.3%	16
Renal failure (all)	1.4%	10
Intracranial heamorrhage	1.3%	9
Respiratory arrest	1.1%	8
Respiratory infection	<1%	7
Fitting	<1%	7
Cardiac infarction	<1%	6
Haemorrhage (all)	<1%	6
Meningitis	<1%	5
Miscellaneous and non-specified diagnosis	5.6%	40

Section 6.10.1.Table 3: Comparison of admission diagnoses T_1 to T_2

	Jul. 1995 to June 1996 (T_1)	July 1996 to May 1997(T_2)
Admissions	326 (12 months)	384 (11 months)
Post-surgical (all)	(54.3%) 177	(39.3%) 151
Respiratory failure (all)	(9.2%) 34	(11.7%) 45
Trauma (all)	(6.4%) 21	(6.5%) 25
Cardiac failure (all)	(5.8%) 19	(7.6%) 29
Infective (other)	(3.7%) 12	(4.2%) 16
Septicaemia	(3.1%) 10	(6.8%) 26
Overdose	(2.5%) 8	(6.0%) 23
Respiratory infection	(2.1%) 7	0
Others	(11.7%) 38	(20.6%) 79

6.10.2 Bacteriology sampling and results

For all admissions admitted to the GITU, from July 1995 to May 1997, there were a total of 3429 samples sent for bacteriology culture, 1760 (51.3%) were cultured positive.

Section 6.10.2. Table 1: Summary of bacteriology samples and positive results

	Jul. 1995 to June 1996 (T_1)	July 1996 to May 1997(T_2)
Admissions	326 (12 months)	384 (11 months)
No. specimens	1916	2513
No. positive cultures	644	1116
% positive cultures	33.6%	44.4%
Respiratory specimens	585	766
Positive culture	**244**	**455**
% positive	41.7%	59.4%
Blood cultures	353	349
Positive culture	**60**	**104**
% positive	17.0%	29.8%

Section 6.10.2. Table 2: Groups of bacteria isolated Jan 94 to May 97

Groups of bacteria isolated	% of total
Candida species	16%
MRSA	12%
Pseudomonas species	9%
Faecal strep.	7%
Coag. Neg. Staph.	7%
Acinetobacter sp	7%
E. Coli	5%
Staph. Aureus	5%
Enterobacter species	4%
Enterococcus species	4%
Klebsiella species	3%
Miscellaneous (31 species each <3% of total)	21%

Section 6.10.2. Table 3: Trends of positive cultures as % of all positive cultures

All samples	Jul. 1995 to June 1996 (T_1)	July 1996 to May 1997 (T_2)
Positive samples	644	1116
Candida species .	23.0%	12.5%
MRSA	12.5%	13.0%
Pseudomonas species.	12.5%	7.0%
Faecal Streptococcus.	8.6%	4.0%
Coag. Neg. Staph.	9.5%	4.5%
Acinetobacter species	3.0%	5.5%
E. Coli	5.5%	4.0%
Staph Aureus	5.5%	3.5%
Enterobacter species	3.0%	3.0%
Enterococcus species	0.0%	6.5%
Klebsiella species	5.5%	1.5%
% of all positives	**88.1%**	**65.0%**

6.10. 3 The study group

Access was obtained to the computerised GITU database and from the Pathology Department from July 95 until the end of May 1997. During this period 255 patients who stayed longer than 72 hours. This was the GITU study group for the research on GITU, representing 36.1% of the total number of admissions to GITU.

Section 6.10.3. Table 1: Summary statistics for the GITU patient staying>72 hr.

Time Interval	Jul. 1995 to June 1996 (T_1)	July 1996 to May 1997 (T_2)
Admissions	326 (12 months)	384 (11 months)
Admissions staying > 72hr.	121	134
% of all admissions	37.1%	34.9%

Admissions staying longer than 72 hours on GITU during the full study period had an average age of 59 years, ranging from 17 to 86 years (SD 16 years) and average length of stay of 11.5 days, ranging from 3 days to 82 days (SD 10.7 days).

During T_1, the 121 admissions who stayed longer than 72 hours on GITU had an average age of 60 years ranging from 19 to 86 years (SD 16 years) and average length of stay of 11.1 days ranging from 3 to 44 days (SD 9.9 days). During T2, the 134 admissions who stayed longer than 72 hours on GITU had an average age of 59 years, ranging from 17 to 82 years (SD 16 years) and average length of stay of 12.0 days ranging from 3 days to 82 days (SD 11.4 days).

Section 6.10.3. Table 2: Summary statistics for the GITU patient staying>72 hr.

Time Interval	Jul. 1995 to June 1996 (T_1)	July 1996 to May 1997 (T_2)
Admissions staying > 72hr.	121	134
Av. age yr.	60	59
SD age yr.	16	16
Males	(57.9%) 70	(68.7%) 92
Females	(42.1%) 51	(31.3%) 42
Av. stay days	11.1	12.0
SD stay days	9.9	11.4
No.deaths	38	30

6.10.4 Bedside audit

Data collection was targeted at all admissions staying on GITU for four site-specific infections. From the introduction of the bedside audit in June 1996 to completion of research in May 1997, a total of 231 sets of documentation were completed for 710 patients admitted to the GITU. This represents a percentage "hit-rate" for nurses' bedside data collection of 32.5%. Further detailed evaluation focuses only on the on the proportion of admissions who stayed longer than 72 hours on the GITU and only for GITU-acquired LRTIs and BSIs. From the time of commencing the bedside audit, a total of 255 patients were admitted to the GITU. The bedside data collection, yielded 69 usefully completed records for the 121 patients staying longer than 72 hours from July 1996 to December 1996 (57.0% hit-rate) and 52 usefully completed records for the 134 patients staying longer than 72 hours from January 1997 to May 1997 (38.8% hit-rate).

Section 6.10.4. Table 1: GITU bedside audit results admissions staying >72 h

	T_1	T_2
No. patients	121	134
Bedside audit	69	52
% patient staying >72 hours included in the bedside audit	57.0%	38.8%
Patients with no bedside audit and no case note audit	0	1
No bedside audit but case note audit	0	5

6.10.5 Retrospective audit

Retrospective data collection in GITU focused on the 169 GITU admissions who had stayed longer than 72 hours during time periods T_1 and T_2 and who also had positive bacteriology results. From the 169 patients identified as potentially having a GITU-acquired infection, case notes were requested, accessed and audited. Three patients staying longer than 72 hours with positive bacteriology had no bedside audit and no case note audit, representing 1.8% (3/169) of the total. Forty-four medical case notes were unavailable or were incomplete. Audit was discontinued in January 1999.

Section 6.10.5. Table 1: Retrospective audit results

Time Interval	Jul. 1995 to Jun. 1996 (T_1)	Jul. 1996 to May 1997 (T_2)
Study group with +ve bacteriology	79	90
% of study group	65.3%	67.2%
Notes audited	58	67
Notes not available or incomplete	21	23

6.10.6 GITU-acquired infection

During the study period, January 1994 to May 1997, 77 patients acquired LRTI or BSI, 37 acquired LRTI only, 13 acquired BSIs only and 27 acquired both LRTI and BSI (Appendix III, Table 1). For all GITU admissions staying longer than 72 hours (382) this represents an LRTI incidence of 9.7% and a BSI incidence of 3.4%. There was a 7.1% of patients acquiring both LRTI and BSI.

In the group of patients staying longer than 72 hours and acquiring LRTI or BSI, there were 54 males (71%) and 22 females (29%). One record did not show details of the patient's sex. The average age of GITU admissions staying longer than 72 hours who acquired LRTI or BSI was 61 years and their average length of stay was 19 days (Appendix III, Table1). The average length of stay for all GITU admissions who stayed longer than 72 hours was 12 days, therefore admissions who stayed longer than 72 hours and acquired LRTI or BSI had an excess stay of 7 days. Those acquiring LRTI only stayed an additional 5 days, those acquiring BSI only stayed an additional 6 days and those acquiring both LRTI and BSI stayed an additional 9 days (Appendix III, Table1).

Analysis of trends of LRTI and BSI show wide variation on a month-by-month basis (Appendix III, Table 2), with numbers of LRTIs ranging from 0 to 5 per month and numbers of BSIs ranging from 0 to 7 per month over the full study period. This represents monthly LRTI incidence rates for the group of patients staying longer than 72 hours (n=382) ranging from 0.0% to 50.0% and monthly BSI incidence rates of 0.0% to 50.0%.

Analysis of trends of LRTI and BSI over the five six-month data collection periods during the full study (Appendix III, Table 3) show that, of GITU admissions staying longer than 72 hours, the proportion of patients affected by LRTI or BSI ranged from 10.9% in the first six-month period of 1995 to 25.6% in the second six-month period of 1994. For the groups of patients staying longer than 72 hours in GITU (Appendix III, Table 3 and Graph 1) incidence of LRTI ranged from 6.5% in the first half of 1995 to 20.9% in the first half of 1994. Incidence of BSI ranged from 6.7% in the first five months of 1997 to 18.6% in the second half of 1994.

The GITU infection incidence for GITU admissions staying longer than 72 hours in the unit was the estimator of the infection. There were 255 patients in the study group and forty-nine patients acquired a total of 44 LRTIs (17.3%) and 24 BSIs (9.4%) which were not present on admission or developed during the first 72 hours (Table 1). Twenty-five patients acquired one LRTI, one patient acquired two LRTIs during their stay. Six patients acquired one BSI. Sixteen patients acquired both LRTI and BSI and one patient acquired 2 BSIs and 1 LRTI. The relative change in GITU-acquired LRTIs from T_1 to T_2 was a 30.2% increase. The relative change in GITU-acquired BSI from T_1 to T_2 was an increase of 25.3%.

Section 6.10.6. Table 1 Incidence of LRTIs and BSIs for patients staying >72 hr

Time Interval	Jul. 95 to Jun. 96 (T_1)	Jul. 96 to May 97 (T_2)	T1 and T2
Study group	121	134	255
No. LRTIs	18	26	44
% LRTIs	14.9%	19.4%	17.3%
No. BSIs	10	14	24
% BSIs	8.3%	10.4%	9.4%

6.10.7 Analysis of risk

Admission diagnosis

Table I shows the distribution LRTI and admission diagnosis, with LRTIs being most frequent in GITU patients admitted for post-surgical care, respiratory failure and trauma.

Section 6.10.7 Table 1 LRTI and admission diagnosis

Admission diagnosis	LRTI	%
Post-surgical	22	50.0%
Respiratory failure	8	20.5%
Trauma	6	13.6%
Infective (other)	2	4.5%
Miscellaneous	2	4.5%
Septicaemia	2	4.5%
Fitting	1	2.3%
Respiratory infection	1	2.3%

Table 2 shows the distribution of BSI and admission diagnosis, with BSIs being most frequent in GITU patients admitted for post-surgical care.

Section 6.10.7 Table 2 BSI and admission diagnosis

Admission diagnosis	BSI	%
Post-surgical	15	62.5%
Trauma	3	12.5%
Septicaemia	3	12.5%
Cardiac infarction	1	4.2%
Miscellaneous	1	4.2%
Respiratory failure	1	4.2%

6.11 Evaluation of the Education Programme

Each of the nine educational seminars was presented twice. A Likert scale was used to evaluate the impact of each session. Each member of staff attending was asked to identify if they agreed or disagreed with statements which evaluated the seminar. A total of eighty staff attended the nine seminars, and 63 evaluations were completed for eight of the nine sessions. For the question which asked staff to identify the relevance of the seminar to the care of patients on the ITU, 100% of staff agreed or strongly agreed with the seminar relevance and provision of useful information. All staff strongly agreed with the relevance of the seminar for prevention of ventilator-associated pneumonia and prevention of IV device related infection. For seven of the nine sessions, all staff agreed or strongly agreed that the seminars provided useful information. Of the two seminars where there was not full agreement on this aspect, 1 nurse was unsure about the usefulness of the information in the seminar on quality and economic impact of hospital-acquired infection in the ITU. One nurse was not sure about the usefulness of the information provided in the seminar on antimicrobial therapy. All staff agreed or strongly agreed that the seminar content would influence nursing practice for: practical bacteriology, prevention of ventilator-associated pneumonia, prevention of IV device related infections. Two nurses were unsure about the influence on nursing practice of the seminar on handwashing and universal precautions. In this seminar, of 12 nurses attending no one knew what the domestic staff's procedure was for cleaning blood spillages with a mop. One nurse was unsure and one disagreed that the content and presentation of the seminar on preventing urinary tract infection was successful.

Evaluation data was accumulated to give an overall evaluation of all nine seminars, all staff agreed or strongly agreed that the seminars were relevant to the care of patients on ITU. Ninety-seven percent agreed or strongly agreed that the content and presentation of the seminars was successful, (1% being unsure and 1% disagreeing - both comments relating to the seminar on preventing urinary tract infection). Ninety-four percent of staff agreed or strongly agreed that the seminars provided useful information (6% were unsure and 1% disagreeing - again both comments relating to the seminar on preventing urinary tract infection). Eighty-five percent of staff agreed or strongly agreed that the seminars would influence their nursing practice. In relation to previous infection control education, 50% of staff agreed or strongly agreed that their previous education in the subject was adequate, with 33% being unsure, 16%

disagreeing and 2% strongly disagreeing. Eighty-four percent agreed or strongly agreed that they would like to attend further seminars at a similar level, 11% were unsure, 4 disagreed and 1% strongly disagreed. Thirty-five percent agreed or strongly agreed that they would prefer seminars with more advanced scientific information, 32% were unsure, 22% disagreed and 10% strongly disagreed. Twenty-three percent of staff would have preferred seminars from an Infection Control Nurse, 28% being unsure, 49% disagreeing or strongly disagreeing. Twenty-three percent of staff would have preferred the seminars from an Infection Control Doctor, 39% were unsure, and 38% disagreed.

Section 6.11.3. Table 1: Staff evaluation of GITU infection control education seminars

	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
Relevant to care of patients on ITU	71	29	0	0	0
Content and presentation has been successful	60	37	1	1	0
Provided me with useful information	57	37	6	1	0
Will influence my nursing practice	44	41	11	3	0
My previous education in this subject was adequate	16	34	33	16	2
I would like to attend further seminars in this subject at a similar level	51	33	11	4	1
I would prefer seminars with a more advanced scientific information	7	28	32	22	10
I would prefer seminars from an infection control nurse	13	10	28	36	13
I would prefer lectures from a microbiologist	3	20	39	25	13

6.12 Evaluation of the Bedside Audit

In October 1996, after three months of bedside audit, 18 staff returned interim audit evaluation questionnaires, seventeen listed both positive and negative points about the documentation for infection control care planning and audit. One nurse did not list any positive points. Seventeen nurses wanted to continue the audit as a research project, 15 thought there was sufficient time to complete the documentation, 6 wanted more information or help to assist in completing the forms, but 11 did not.

Nine staff wanted to keep the system as it was, without changes, five did not. Nine would keep the current system, but change it in some way. Thirteen nurses felt that the infection control audit should become a permanent part of the patient's record.

Forty-three positive points made by the 17 nurses responding. Individual comments were collated and analysed to identify major themes. The majority of positive comments related to raising awareness (11), improved patient care (9), improved information (8), benefits in relation to specimens and test results (6), improved risk assessment (5). Only two comments related to knowledge of infection incidence. Two miscellaneous comments were made: *"All nursing research is a step in the right direction - in justifying "Nursing" as a true profession"* and *"Legal issues/standard setting"*

Section 6.12.Table 1

Individual comments relating to raising awareness
• *"See areas where improvement of practice is required"*
• *"Identifies areas of concern in relation to infection control measures"*
• *"Increases awareness of need to (follow) correct procedure"*
• *"Raises awareness"*
• *"Encourages regular infection screening"*
• *"Increases multi-disciplinary team awareness & vigilance"*
• *"Learning tool for new staff"*
• *"It makes people more aware of infection control"*
• *"It makes you much more aware of potential problems/risks – especially for junior staff, but for all grades"*
• *"It makes you less likely to forget about things like cannulae or giving set changes"*
• *"Increases awareness of techniques in infection control"*

Section 6.12.Table 2

Individual comments relating to improvements in care
• *"Improves patient care"*
• *"Helps (sometimes) to identify the source of infection"*
• *"Improved patient care"*
• *"Aid better nursing care"*
• *"Improve infection control"*
• *"Shorten patient's stay in GITU"*
• *"Aims to improve infection control"*
• *"Continuity of care"*
• *"Improve patient care"*

Section 6.12.Table 3

Individual comments relating to improved information
• *"All the information is in one folder with clear chronological data inc. all relevant aspects"*
• *"Quick to complete daily documentation"*
• *"Relevant to area of work"*
• *"Easy to use once explained"*
• *"Evidence in written form"*
• *"Feedback"*
• *"Easy to complete"*
• *"Evaluates"*

Section 6.12.Table 4

Individual comments relating to benefits in specimens; tests and results
• *"Makes nurses look at infection control e.g. WBC"*
• *"Encourages you to look at specimen results"*
• *"Evaluates why/when specimens should be taken"*
• *"Draws attention to blood results"*
• *"Highlights positive bacteriology"*
• *"Up to date with results of specimens sent"*

Section 6.12.Table 5

Individual comments relating to improved risk assessment
• *"Identifies problem areas"*
• *"More conscious about infection risks when doing the daily documentation"*
• *"Highlights problem areas"*
• *"Draws attention to potential risks of infection"*
• *"Draws attention to length of time lines have been in"*

Section 6.12.Table 6

Individual comments relating to knowledge of infection incidence
• *"Able to correlate amount of hospital-acquired infection"*
• *"Increases knowledge of infection incidences in GITU"*

Twenty-eight comments were made relating to the negative aspects of the audit and care planning system, individual comments were collated and analysed for major themes. The majority of negative comments were related to time for completion of the forms (13), with 8 nurses thinking the system was difficult to complete, use or understand. Miscellaneous comments were made *"can be generalised- needs to be more specific", "written diagnoses in medical notes do not always state what date the samples were taken on", "seems to be task orientated",* and *"I sometimes forget and I know others do".*

Section 6.12.Table 7

Individual comments relating to time required to complete documentation
• *"Time consuming when no-one else fills it in"*
• *"Time consuming to chase up results to fill form in correctly"*
• *"Takes time to complete - especially at onset of documentation"*
• *"Would be if extended - time consuming"*
• *"Time consuming"*
• *"Time consuming"*
• *"If not filled in daily -very time consuming tracing back results"*
• *"Initially time-consuming"*
• *"Time consuming"*
• *"Time consuming"*
• *"Time consuming"*
• *"Time constraints"*
• *"[the..] time to fill it in (but in reality this does not take long)"*

Section 6.12.Table 8

Individual comments relating to additional paperwork
• *"Extra paper work"*
• *"Sometimes I am too busy to do extra paper work"*
• *"Another piece of paper"*

Section 6.12.Table 9

Individual comments relating to the documentation being difficult to use or understand
• *"No proper education about how to fill them in, hence poor/inaccurate records (I started in July)"*
• *"Some of the results can be misleading"*
• *"Not sure of objectives"*
• *"Often difficult to follow up bacteriology results"*
• *"Not always easily understood"*
• *"May not be completed correctly"*
• *"Due to rotational posts in ITU, new staff have difficulty in completing the daily documentation"*
• *"? More teaching sessions required"*

Section 6.12.Table 10

Individual comments about continuing the research beyond the pilot stage
• *"will keep awareness high"*
• *"strive to reduce cross-infection"*
• *"infection control is easily forgotten, constant audit will keep awareness high"*
• *"areas of infection control can be forgotten when busy, reminds you how important it is"*
• *"identifying problems so they can be dealt with"*
• *"yes please! Makes people more aware of the importance of infection control"*
• *"because people become more aware of infection"*
• *"If there are benefits to patients in the long run, then I'm all for that"*
• *"nursing future is in research based practice"*
• *"nursing care should be continually research based to improve patient care"*
• *"because it is going so well, I feel it is a good motivator for staff"*

6.13 GITU research development

Data feedback was given to staff at an interim stage and a series of seminars to present and discuss final results. Graphs, charts and explanatory comments were displayed on the notice board in the coffee room. As in a previous study, nurses did not at first grasp the graphical representations and welcomed the interpretation of the results. One Health Care Assistant announced that, after seeing the graphical displays, she did not want to join the results seminar as she would not be able to understand, but after being coaxed into the seminar was pleased to announce that, *"she did understand-now".*

A project team was created to determine how best to use the results of the research. A team was set up to look at documentation, education and audit. Because there was no major changes in infection rates as a result of the bedside audit, it was agreed not to pursue this route, but to develop a care planning document for all patients which would form part of their routine documentation for care planning, communication and evaluation (Appendix III, Charts 9 and 10) with a prompt sheet for risk factors (Appendix III, Chart 11) and definitions for acquired infection (Appendix III, Chart 12).

The GITU also used a computerised care planning system and a problem and evaluation sheet was written into this system for routine use in daily care planning.

Infection control planning and evaluation started at completion of the study (June 1997) and continues to the present date (January 1999). It was agreed to continue the education when the Researcher was able to provide the resources used in the study and that audit of infection could take place again at some point in the future to evaluate changes.

Bacteriology data were analysed by sequential order (by date), by individual patients and by bacteria cultured. This was provided as a paper version and computerised. It was suggested that it could usefully be included within the main GITU database and identify patterns of antibiotic usage with patterns of antibiotic resistance. At this point the researcher is not aware if this has happened, although it is unlikely because of the limits on clinical staff time.

6.14 GITU research dissemination

The researcher presented results of the research at a multi-disciplinary study day organised by the GITU. This included presentations by the GITU medical consultants, the researcher and two GITU sisters who presented results of qualitative studies in the GITU. In discussions following the presentations, nurses called for more multi-disciplinary research, one consultant replied that whilst they could understand the action research study in infection audit, they did not understand the qualitative studies.

6.15 Future research and development plans

The discussion at the study day became a catalyst for a collaborative research study undertaken for the Clinical Management Team (CMT) within the GITU. This programme of research has focused on two aspects of critical care, one has been to explore the potential for nurses to discharge patients from HDU and the other has been an audit of "at-risk" patients in the general wards. Both projects have been led by nurses on behalf of the CMT and have been facilitated by the researcher during 1998 and 1999. From 1997, research results have been disseminated by the researcher at 5 national nursing conferences, 2 regional conferences and will be presented at two further conferences in 1999, one being a symposium. The Researcher is in contact with one other nurse researcher who is using action research to explore knowledge and practice of doctors and nurses in a care of the elderly unit, focusing on *C. difficile* and MRSA infections. Further action research sites have been identified to test the research methods in a variety of clinical settings.

Chapter Seven

Discussion

Patients admitted to the intensive care unit remain at much greater risk of hospital-acquired infection than those admitted to general wards. Traditionally responsibility for the patient's microbial environment has rested with the medical team, however, despite a wealth of published research, health professionals are failing to comply with recommended infection control practices. The nurse, in close proximity to the patient is ideally placed to adopt a primary role in preventing infection in the intensive care unit. Whilst a proportion of infections are unavoidable, due to patient and environmental risk factors, there is potential to reduce infection rates by improving clinical practice. Studies have demonstrated that proactive intervention can break the chain of events leading to hospital-acquired infection. Evidence-based practice requires that clinicians obtain evidence, implement the evidence and evaluate the effect this has on patients and resource usage. Improving the clinical effectiveness of services is one of the major challenges currently facing the NHS (Moores 1997). This theory-practice gap is not unique within nursing. However, in the context of infection control, it results in the serious situation of the nurse's inability to transfer knowledge of effective practice to deliver effective and efficient care directed at protecting the patient from potentially preventable cross-infection – which, in the case of a patient requiring intensive care, can be life threatening. The nurse's ability to provide effective infection control depends upon a number of complex inter-related factors. These include acquiring a perception of the problem of hospital-acquired infection, learning applied microbiology, development of competence to use appropriate clinical infection control skills and possessing a level of personal motivation to comply with research-based infection control recommendations. Therefore, enhancing perception of hospital-acquired infection by providing a working knowledge of the scale of local problems of hospital-acquired infection should increase personal knowledge and use of appropriate actions. Awareness of the extent problems should highlight areas of responsibility & accountability and bring a recognition of the nurse's responsibility to act proactively to prevent infection. Thus motivated individuals will apply appropriate theory to their clinical nursing practice. However, rates of endemic hospital-acquired infection are generally not known in the UK. The most efficient infection surveillance methods developed for use in the UK are too time consuming for practical use. Debate on methodological issues continues in the UK without national consensus on definitions for infections (Crowe and Cooke 1998).

A gap exists between immediate clinical needs and the production of useful information. Delays in developing integrated hospital information systems leads to an inability to provide any local measurements of endemic hospital-acquired infection. This means there is no convincing evidence on which to support recommendations for change in education, clinical practice or research. Surveillance of endemic infection has been developed in the USA using methods with sufficient sensitivity to reflect infection rates as a quality indicator without being too time and cost consuming. Haley (1995) stated that increasing numbers of hospitals in the USA are demonstrating large reductions in their rates of all categories of hospital-acquired infection. He believed that the effective approaches taken in the USA are firmly grounded in the science of the SENIC project and proposed that new approaches and techniques for infection control would ultimately reduce, *"the scourge of nosocomial infection to its irreducible minimum"*. Ensuring that infection control practice is effective requires reliable measurement of endemic hospital-acquired infections. There is a long-term need to address the methodological issues for reliable measurement of endemic hospital-acquired infection, but the immediate issue is one of balancing the validity & reliability of any chosen system with its costs & clinical utility for infection surveillance.

The problem of hospital infection and the difficulties in its effective control is well recognised and research-based recommendations have been made for changing clinical practice. Infection surveillance combined with responsive infection control methods have been shown to be the most effective way to reduce rates of infection. However implementation of these changes is proving difficult to achieve in the UK. Reduction of hospital-acquired infection relies on improvements in infection control - such as handwashing or care of invasive medical devices - but health professionals have difficulty learning and integrating this knowledge in practice. Clinical practice of infection control, particularly handwashing, is sub-optimal and health professionals appear to be resistant to changing their infection control practice. Workloads in the NHS are rising and resources are limited. There is a lack of useful clinical information and limited use of information technology to provide knowledge-based systems which can guide practice, education and management for infection control. Hospital-acquired infection is costly, causes pain & anxiety and in some cases causes death. Health care professionals must rethink their roles, responsibilities and relationships with other health professionals. Infection control is one of the services that can potentially improve quality of care, improve patient outcomes and save money.

This study aimed to explore a new, practical and potentially cheaper way of applying research evidence in a UK setting. It was a conscious attempt to develop a comprehensive programme for quality improvement combining surveillance of infection with improved infection control utilising the problem solving approach of the Nursing Process and its associated documentation. Care was taken to promote the research in a non-threatening way and develop a collaborative, flexible approach to change. Responses from both ICUs showed that prior to the research there was little evidence of nursing or medical documentation for infection risk assessment, evaluation or outcomes monitoring. In both ICUs permanent changes occurred as a result of the study; with 80% of PICU admissions and 57% of GITU admissions staying over 72 hours being included in the infection control risk assessment, care planning, process & patient outcomes monitoring. This meant that routine clinical data could be used to audit acquired infection and the data items could be incorporated within an audit tool. This tool was introduced in practice and established a benchmark for comparison in the future. This is a major aspect of the research which should receive a high profile in dissemination of the results. In both ICUs there were improvements in:

- patient- and therapy-related infection risk assessment
- infection control process monitoring
- documentation of patient outcome
- information about risk factors and ICU-acquired infections and
- in knowledge about commonly cultured bacteria in the ICU

Information and information systems were better in GITU than PICU, but neither ICU had a system for routinely recording patient severity of illness scores. Data collection targeted all patients, but in practice many patients admitted to the ICUs were missed. Data collection yielded few surgical wound or urinary tract infections in both PICU and GITU, meaning data analysis could only usefully include respiratory tract and blood stream infections for those patients staying longer than 72 hours. On reflection this may mean that nurses were encouraged to collect data which was then not collated or analysed. This could be viewed as unethical. In justifying the approach, if data collection had primarily been focused only on patients who stayed longer than 72 hours, the inclusion rates for these patients would probably have been much lower.

The PICU was a small unit where the researcher was well known. The rate of bedside and retrospective data collection was good and information was easily collated from the bedside documentation and medical case notes of children. The GITU was a large unit, where the researcher had no previous connection. In contrast to the complete ownership of the PICU research by the PICU research co-ordinator, the researcher maintained a higher profile in the GITU than the PICU. In practice this meant that only partial GITU staff ownership of the research was achieved. This may have contributed to reduced rates of GITU patients included in the bedside audit. In addition, although medical case records from GITU were accessible, the clinical information within the case records was not. There were often many volumes of GITU patients' case notes and not all volumes were accessible at one time; some volumes were stored in different locations in the hospital. Some patients who appeared to have only one volume of case records had no record of their GITU admission. Information recorded in the GITU case records was not as good as information in the PICU case notes. In many cases an infection was queried with no documented evidence of patient outcome. Often patients had clear documented evidence of positive cultures and antibiotic changes without any reference to infection in the case notes.

Both ICUs had lower rates of LRTIs and BSIs than found in the study by Glynn *et al.* (1997). Rates of both LRTIs and BSIs were slightly lower in GITU than in the PICU and it is important to note that changes in practice will only on impact rates of infection if there is potential for improvement. There was a high inclusion of children who stayed longer than 72 hours in the PICU, therefore PICU rates may be useful in interpreting the impact of bedside audit on changes in infection rate over time. Rates of LRTIs in the PICU reduced, but not to a statistically significant level. BSIs rates increased. The marked increase in numbers of children with more severe diagnoses admitted to PICU highlights the increasing trends for sicker higher risk children requiring intensive care. However, average lengths of stay in the ICU reduced. This would increase the intensity of work and place added strain to any system for effective infection control. In the GITU there was little change in case-mix, age or lengths of stay, LRTIs and BSIs in GITU actually increased after the introduction of the bedside documentation.

Observations made in this study suggest that if there was any impact made by the introduction of nursing risk assessment, process and outcomes monitoring for ICU-acquired infection then it was on rates of LRTIs in PICU. As with the previous study in a surgical unit during 1992-4 external data collection and facilitation may not be as advantageous as compared with ward nurses completely owning all aspects of data collection and infection control practice developments. Inclusion of children staying longer than 72 hours in the PICU led to better completion of the documentation than in the GITU. The data collection has continued on the PICU due to the success of the internal PICU research co-ordinator and the research documentation was adopted by the PICU as routine practice. Inclusion rates in GITU dropped after the researcher had completed the awareness raising infection control educational sessions. Within the GITU it was not thought feasible to continue the bedside data collection for the full audit and care planning system.

Results did not demonstrate any relationship between the research interventions and reduction of infection rates. Therefore, the research hypothesis was not supported and alternative reasons for explaining the increase on BSIs in PICU and LRTIs & BSIs in GITU could be that:

- there was potential for change - interventions did not change practice,
- there was no potential for change in infection control practice
- changes in practice occurred but made no impact on patient outcome
- the infection rates were at *"an irreducible"* minimum
- some other *"unknown"* factor not in the control of nurses or nursing

However, permanent changes were made to existing documentation in both ICUs. Each patient admitted to GITU now has a paper-based core infection control care plan and evaluation page for problem identification and communicating changes in care. The written infection control care plan and evaluation sheet and risk awareness sheets were included in all patients' clinical records. This is generic to all aspects of infection control. Each patient also has a laminated infection control awareness check-list, including risk factors for infection and the staged definitions for lower respiratory tract, blood stream and urinary tract infection. Surgical wound infections are excluded, but urinary tract infection monitoring remained. An infection control component has been added to the GITU computerised nurse care planning system.

In the PICU there was a 44% increase of admissions staying over 72 hours, but only an 18% increase in bacteriology samples. In the GITU there was an 18% increase numbers of admissions with a 31% increase in the number of samples being sent for bacteriological culture. No details of bacteriology results were available from the PICU, but in the GITU there was a 73% increase in the number of positive cultures from all samples; an increase of 87% for positive cultures from respiratory samples and a 73% increase in the number of positive blood cultures. The simple explanation for this observation could be that relatively higher numbers of admissions caused an increase in bacteriology sampling. However the proportional changes were different in each ICU. PICU had a considerable increase in numbers of admissions, yet compared with the GITU a smaller increase in the number of samples being sent for culture. In the GITU the smaller increase in numbers of admissions was associated with a considerable increase in samples being sent and an even higher proportion of positive samples being cultured. This observation may reflect a reduction in infection in the PICU and an increase in infection in the GITU, but it is necessary to consider other possible factors for these changes. The bedside audit may be seen as the factor causing the increase in bacteriology sampling in the GITU. If this were the case, does the associated increase in LRTIs in the GITU mean that there were simply more LRTIs in the second time interval after bedside audit commenced or just more LRTIs being detected as opposed to being *"missed"* or un-recorded in the previous period. Not all positive bacteriology cultures represent infection. However, the high proportion of positive cultures in GITU may indicate that a higher proportion of patients are being admitted with a pre-existing infection or higher colonisation of patients in ICU associated with environmental bacterial or an increase in ICU-acquired infection. Information on patterns of bacteria being cultured can be seen as a marker for the types of bacteria that are commonly associated with the unique environment within each ICU. This in turn would help to identify common causes of colonisation and infection. If clinical information is linked with knowledge of the aetiology and epidemiology of acquired infection and combined with knowledge of potential sources of infection, the possible routes of transmission and the infection process, then the health professional could adopt a rational approach to preventing cross-infection. When this information is unknown there are no means to determine effectiveness of care - practice becomes a series of rituals and routines with no scientific basis.

The research was restricted to the extent to which the research interventions were directed towards influencing nurses, nursing and how nurses saw their role in infection control. Whilst senior medical staff (both intensive care and infection control) were involved in setting up the study the influence on more junior medical staff, those doctors who deliver the majority of direct medical care would be limited. This may have lost the potential opportunity to influence medical practices in these areas, and this would need to be considered when planning further studies in this field of enquiry.

The retrospective audit relied on computerised data and clinical information documented within the medical case notes. The system used within this study would not identify patients who had been treated for infection, but had no details of a swab or sample sent for bacteriology culture recorded in their case notes. Nor would it identify patients who developed an infection after discharge unless there was written evidence of infection in out-patient or casualty records. Errors within the system for retrospective data collection developed for this research, which combined only documented clinical indicators for infection, would have resulted in an underestimation of the true incidence of infection rather than an overestimation. The use of positive bacteriology results, as preliminary markers, could be a more suitable cost-effective approach to identifying cases of potential infection.

Documentation promoted inter-professional discussion about infection control issues and the profile of infection control was raised in both sites. Results of the exploratory information gathering in both ICUs became the focus and impetus for change. ICU staff were willing to open up discussion on the issues and problems within their unit and make recommendations for change. Nurses improved knowledge and understanding of the subject, this appeared to be facilitated by the use of the bedside audit and infection control education programmes. Nurses increased their involvement in bedside communication of infection control issues. GITU nurses who attended the modular education sessions indicated the information was useful and that the content would contribute to changes in their practice. The raising of the profile and importance of infection control was slow, but there was an obvious change. Infection control became integrated in practice.

Development of the documentation matched the aspirations for a clear, objective complete system to support infection control care planning and audit. Data items

were successfully incorporated within the audit documentation for measuring incidence of each of the four site-specific infections. Definitions for each site-specific infection being measured were adapted from published definitions, but matched the way that nurses assess their patients' infectious status. In the two sites that accepted the research programme the documentation received support of all stakeholders both within and outside the ICUs. Pre-coding of the majority of data items reduced the amount of time needed to complete the documentation on a daily basis. This was estimated to take only 5 for each patient if the documentation had been filled in correctly on previous days and there were no changes made in the definitions for each of the four site-specific infections. The use of internal ICU facilitators as co-developers of the documentation meant that whilst they acquired a working understanding of infection control in the ICU, they also learnt about the processes necessary for successful research in clinical practice – this was regarded as useful for their own professional and personal development. Although some nurses were not particularly interested in the topic of infection control, the majority were curious about a nurse leading a research project which was clinically relevant to the world of the ICU. Involvement in the research seemed to have an impact outside the remit of the researcher. Both ICUs established internal infection control quality improvement teams. Whilst only PICU retained all aspects of the research and introduced these changes as routine practice, both ICUs have become research active. The problems of the theory-practice gap are discussed ad infinitum in the nursing publications and all health professionals are encouraged to become research aware. However, barriers to research are high, particularly for staff working in the environment of the ICU, and a by-product of this research has been the development of an evaluative culture in both ICUs. In both units nurses are leading clinical teams in multi-disciplinary clinical research programmes. There has been an obvious increase in confidence, research capacity and research capability. The research has provided an opportunity for personal development, which although hard to quantify, has been the most satisfying aspect of this programme of research.

The reactive nature of intensive care and increasing pressures on provision of ICU services means that increasing numbers of patients are being treated with reducing lengths of stay, thus exposing patients, staff and visitors to high risk of acquired infection. Both ICUs were in large teaching hospitals in the North of England. Both were busy units and experienced similar concerns and issues. There was a

national shortage of ICU beds and problems recruiting experienced ICU nurses. Intensive care units face variable workloads and difficulties in maximising their resources. In these working situations issues of job satisfaction and staff morale would impact on staff motivation levels. Both ICUs were initially funded to have fewer beds open than was physically available and both units experienced pressures to open addition beds. Both ICUs followed national recommendations for nurse staffing, operating on a 1:1 ratio for nurses to patients with an additional nurse who co-ordinated the management of the unit. However many aspects of direct nursing care require at least two members of staff and in both ICUs medical staff had responsibilities in other areas of the hospital providing potential for cross-infection.

Despite a low response rate to the questionnaires, the quality and quantity of responses to the open questions were helpful in identifying staff perceptions of infection control in the ICU. Staff from both ICUs perceived a need for some improvement in infection control in their own unit. Responses indicated that the assumption that pre-registration education is addressing the changing needs for effective infection control is questionable. Respondents perceived that they had inadequate levels of pre-registration education, poor knowledge & practice of infection control. Responses revealed the baseline perceptions of ICU nurses current infection control practice and the complexity of infection control in ICU. Staff perceived the nature of ICU work as restricting basic infection control actions and there was evidence of infection control being an optional extra to be conducted when there was time. ICU nurses' self-reported hand hygiene practices were good, but knowledge of infection control policies was poor. An assumption that failure to perform handwashing in ICU is due to high workloads is supported of staff giving as a main reason for poor compliance with infection control *"shortage of time* in both ICUs. However, *"confusion over correct procedure*" was a more common choice for GITU staff and was second in frequency of responses in PICU. The frequency of the response *"forgetting"* was more frequent than *"poor handwashing facilities"* and some staff responded that infection control compliance was *"not always necessary"*. Responses indicated a general low level of self-confidence in infection control knowledge and practical skills. Results revealed an inter-professional *"us and them"* situation where medical staff made comments about nurses and nurses made comments about medical staff. This might be best

described as a light-hearted *"blame culture"* for poor infection control. The majority of staff wanted improvements in education, training and clinical practice, particularly in relation to handwashing and improving clinical practice. Staff expressed need for more information, but they wanted mandatory infection control training days, indicating that they wanted to be made to attend, rather than seek out this knowledge through normal professional development opportunities.

Nurses are at the bedside in the ICU over a full 24 hour period and in such a position would (or should) be the natural co-ordinators and communicators of care. The majority of nurses in both ICUs always or sometimes read bacteriology reports, but many fewer responded that they always understood them. Although numbers of staff reporting lack of understanding were low, infection control is only as strong as its weakest link. Successful infection control depends upon knowing a patient's infectious status and the organism causing problems and knowing the infection status of a patient depends on knowing the bacteria cultured. The method for identifying and communicating this information is the bacteriology report. Just one member of a large ICU team who, for whatever reason, fails to understand the necessary processes which should be followed allows failures in any system for infection control. ICU nurses work on a one-to-one ratio with ICU patients. It should be a matter of concern if an ICU nurse does not know the immediate infection status of the single patient she is responsible for. If this were the case, this would mean that the ICU nurse would not know the most appropriate action to protect the patient, other patients, other ICU staff and visitors to the ICU. It was apparent that only a few staff always incorporated bacteriology results in the patient's care plan. The implication of this finding is that the role of the qualified nurse at the bedside should be given more prominence in discussions on infection control. The nurse within the ICU has a complex role to play, both for the control of the intensive technology for life support and for the physical and psychosocial needs of the patient.

Nurses interpret large amounts of information and make real-time decisions based on this information gathering. However, nurses who perform risk assessment without showing any record of having performed this aspect of care are exposing themselves to external criticism. Nurses are accountable for their standards of care and the improved infection control documentation developed in this study makes explicit the nurse's role in infection control care planning, delivery of

responsive care and evaluation of the impact of nursing care on patient outcomes. This research highlights the responsibility that nurses have in ensuring adequate recording of infection control information is completed on every patient – an essential component of evidence-based practice necessary for the effective delivery of clinical governance in the health service. ICU nurses need to emphasise the interactive complexity of their role and should be encouraged to document risk and actions taken to prevent or minimise those risks.

Communication of information is a key aspect to care in the ICU, each nurse is dedicated to one patient's care and should be able to update information in the patient's record which is relevant to that patient's care and the care of other patients, staff and visitors at risk. Omitting to record presence of infection poses a greater risk for staff who follow on with care for the patient in the ICU. Nurses are accountable for standards of clinical practice and need to comply with recommendations for evidence-based practice. Documented evidence is necessary to demonstrate that infection control care planning and action are based on individual risk assessment and elements of care that are planned are actually delivered and evaluated. The reactive nature of ICU care means that interventions cannot always be fully planned in advance. Considering the risk posed by acquired infection for patients requiring intensive care, with an increased associated mortality from pneumonias and septicaemia, progress in infection control should be seen as a continual striving to plan and deliver high standards of quality care at all times. Breaks in infection control, or *"infection control violations"*, should be recorded and critically analysed to determine the best way to prevent this sort of action in future.

McCormack (1999a) discussed a model for implementing research into practice, describing factors for success and proposed that service improvement is a function of the strength of the evidence base; the context or prevailing culture and appropriate facilitation. He described the factors within an interactive, dynamic matrix which can be used to identify and analyse practice development projects. Using McCormack's framework for analysis of this study, the strength of the evidence in this study was high, but not of the highest order of randomised controlled trials. The context and prevailing culture of each ICU was clear - patient-focused, multi-disciplinary with prevailing medical dominance, an educative culture with strong self-image of professionally led care. There was clear consensus of

views and facilitation was appropriate. There was external facilitation to an internal PICU facilitator and external facilitation to a GITU internal team. In presenting the evidence to clinical staff, success was achieved in agreement with McCormack's (1999) *"enabling factors"* for practice development. There was researcher sensitivity to, and an awareness of, the specialist nature of intensive care nursing, with obvious need for nursing involvement in the project. There was a raising of awareness to both clinical and cost-effectiveness issues with commitment to individual and team nursing development. The overall aim was one of practitioner ownership with management support. Changes were approached systematically and were in support of an established professional vision of practice development and evidence-based nursing practice. There were political overtones to the facilitation of the changes with promotion of the role of ICU nurses as highly specialised, intelligent and unique. The issue of ICU nurses' potential replacement by technical staff and NVQ level trained assistants was recognised by ICU staff. With this in mind, involvement in the research was promoted as a means of demonstrating implicit actions of qualified nurses. Nursing actions emphasised were risk assessment, risk management and nursing actions aimed at prevention of infection. This highlighted the case for retaining highly skilled qualified nurses within the ICU.

Continuing in the use of McCormack's model for identifying successful implementation of research into practice (McCormack, 1999b), development achieved in this study was predominantly an attitudinal change to ICU-acquired infection, ICU infection control and the role of ICU nurses in infection control. There was evidence of an increasing confidence in the nurses' competence and understanding, with nurses gaining a deeper understanding of the significance of bacteriology results for care. There was a clear focus on nursing care processes with development of clinical leadership in practice development. In common with Hope (1998) the researcher had been active in practice development long before her awareness of the appropriateness of the theoretical framework of action research. The researcher had been initially frustrated with being unable to proceed with a particular form of research (the controlled trial) and gained *"energy"* from the paradigm of action research, which Hope (1998) described as, *"characterised by decisions trails and logistics which are context bound, complex and open to confusion".* In considering this description, Hope (1998) expressed concern that

the existing literature on action research generally understates its complexity. He argued that actions are not *"neat and linear"*, which in itself, generates a problem when trying to describe the process of action research using an accepted academic approach. He used the analogy of action research as a journey which involves change, but which is a *"serendipitous"* process involving areas of: language and discourse, activities and practices and social relationships and organisation. He cited Waterman *et al.* (1994) who argued that the problems of defining action research can be seen as a symbol for, *"artistry and flexibility in the practice of nursing and action research". F*acilitation took similar but slightly different roles in each ICU, but was predominantly external facilitation to an internal ICU facilitator. Facilitation was aimed at being flexible and collaborative, but at times needed to be directive and persuasive. Strong emphasis was placed on the importance and relevance of the educative and developmental processes for nurses and nursing.

The researcher's experiences in this study were in agreement with Titchen's (1999) who, in discussing her role as external facilitator in a long-term action research project, described her relationships with clinical staff as one of a *"critical companion"*, being sensitive to needs and responsive to differing individuals and groups. Using the accepted theoretical framework of critical social science, she described practice development as a process of integrating of *"professional nursing craft knowledge"* with a research base. Titchen (1999) described the relationship between a practice development facilitator and the nurses being facilitated as; requiring respect, mutuality and reciprocity with demonstration of *"living out shared values and beliefs"* within a process of *"learning from practice".* Whilst facilitation in this study took both directive and flexible approaches, there were elements of the four components thought by Rolfe and Philips (1997) to be highly influential in the personal qualities of an individual change agent: personal, interpersonal, intellectual and educational. In this study all these qualities were utilised and the relationships built with the internal ICU change agents, were and are sustained on both personal and professional levels. Hope (1998) holds the opinion that most nurses are equipped with the skills necessary for action research, *"having well developed interpersonal skills, flexibility to respond to new situations, a degree of social entrepreneurialism, a willingness to listen to alternative views and the ability to be reflective and reflexive"*

Because of the inability to control confounding factors such as patient risk and workload, crude unadjusted figures have been used to interpret the value of the research. Confounding variables cannot be eliminated or controlled within applied clinical research. Nurses cannot be isolated from other healthcare workers and the nature of ICU care is complex and subject to change, with extremes of workload and finite resources. Action research provided a flexible approach that suited the adaptation of the researcher's views on infection control in intensive care units and translated what is regarded as an academic and scientific subject into practical clinical terms. Put another way, knowledge gained about prevention and management of infection within this research was derived from clinical practice with changes occurring at the interface of patients and their carers. Action research was used to determine the potential for change, to introduce change and understand the nature of the changes. It used an intuitive approach, favoured by nurses who generally see the value of education and practice development and who generally focus on the nursing processes of care. Nurses find difficulty in defining outcomes of care and identifying or demonstrating the relationships between processes of care and patient outcomes. This was borne out by the results of the GITU audit evaluation when nurses were asked about potential positive benefits of the audit. Most comments related to improving care and raising awareness to infection & infection control. Few nurses felt that knowing rates of infection was a positive benefit to them. The highest anxiety that nurses felt when considering involvement in the research and evaluating its impact was the time taken for completion of the audit, problems of missing data items and concerns over having to complete more paperwork. Using action research and Lewin's theory of change enabled the researcher to validate previous approaches to change interventions and support the view of sustainable change being part of a slow incremental process. The research was promoted as an *"act of faith"* without any preconceived ends-points. Being open with staff and promoting the use of action research, or *"real clinical research"* was educative for both staff and researcher. It introduced a partnership, or *"bond"* between researcher and motivated staff. Action research was seen as a process rather than a means to an end and certainly gave focus to the research. It drew considerable attention to the processes involved. In both ICUs there was an emphasis on infection control education and its intrinsic value. Even if the research *"failed"*, there would be a pay-back in that nurses would have clinical information about local problems.

Many nurses were involved in education programmes and the research was able to bring alive some of the theories introduced in the classroom. The researcher had considerable experience in this field of study, but was conscious that imposed change without negotiation is not welcome by current NHS staff. Within this study, in contrast to many new projects introduced into the NHS, at all points of this research ICU staff were given control. Whilst senior nurses actively promoted data collection, the approach was to promote staff involvement in the research as *"voluntary".* There was little change in plans but ample opportunity was taken with all grades and groups of staff to allow changes to be made. Conducting research in the NHS has many challenges, health service researchers need powers of persuasion whilst at the same time upholding the rights of patients and clinical staff. At any stage one member of the wider team in a hospital could withhold consent to proceed. In contrast to the open unstructured approach to change taken using the action research, the research process needed to be structured. Fortunately, the research problem lent itself well to the structured approach of evaluative research. The research design followed a classic approach in its development with problem identification, development of a research question with aims, objectives and hypothesis with statistical considerations being made. This was a considerable asset when seeking and gaining support from the medical clinicians, the Infection Control Team and particularly when applying for ethical approval for the study. The predominant concern of the medical team on the PICU was the use of non-published, non-validated definitions. But they were persuaded that the research was exploratory in nature and that gold-standards do not exist in the UK for defining hospital-acquired infection. It was emphasised that the focus of the research was on the clinical utility of the audit balanced by clinical validity and reliability. The immediate need was to address clinical problems, to develop user-friendly methods of data collection and to develop further research programmes to test and validate the methods. New research programmes were indeed developed. Further analysis of the available data will proceed shortly and further research is planned to test the approach in other units and to determine the cost and potential benefits. Research data is computerised and maintained in such a way that further validation of the accuracy of the measurement can be made. The contribution of risk factors to the development of infection will be explored. Data will be analysed to provide an audit trail of events which will indicate the time from first signs and symptoms of infection (and possibly pre-infectious indicators) to the first sample taking, first bacteriology result and first therapeutic intervention.

Measurement of ICU-acquired infection provided useful information for future local comparison purposes. Data showed trends of infection over time, identifying problems in each ICU and provided a basis for quality improvement. The documentation was designed to collect and collate only routine items of clinical information that the nurse at the bedside on an ICU would already know or be able to access in a very short time. The actual recording of data should pose a negligible burden on nurses who are constantly by the bedside in ICU. Whilst the results do not indicate general improvement in patient outcome occurring over time, the method of data collection was applied systematically and rigorously. Aggregated data showed trends of infection over time, identifying problems in each ICU and provided a basis for quality improvement initiatives in the ICUs. However, the reliability and validity of the results should be weighed against the potential clinical utility.

Accepting the limitations of this study, the approach taken has potential application for surveillance of endemic hospital-acquired infections in a wide range of clinical specialities. The system provided a framework for case-mix identification, case definition, data collection and identification of indicators for measurement of ICU-acquired infection which can be adapted to meet specific requirements of different clinical situations and which is directly related to improving patient outcome. It was shown to be feasible systematically to incorporate the audit tool within routine documentation of clinical care with apparent cost-effectiveness, although this was not formally tested. There was, of course, input from the researcher who was supported full-time on a studentship and provided time and resources to initiate the study, develop documentation and educational resources, ICU staff time was also needed for development and management. No additional test or interventions were required; the impact was the adherence to standardise routine systematic risk assessment, with more responsive care planning, which should have contributed to improving the prevention and management of infection control in the ICU.

As no relationship was shown between the research interventions and changes in all the outcome measures, the results of this exploratory study must be treated with caution. Although bedside data collection did not include every patient regarded as at high risk of acquiring infection, i.e., those admissions staying longer than 72 hours, there was a high proportion of PICU admissions included and a considerable number of GITU patients who also were included.

The higher the inclusion of patients the higher the confidence that the method developed within this research provided results which truly reflect patient outcome. Data collection was more complete for PICU than GITU, therefore because of the missing data generalisations have to be made and the clinical value of the approach should be carefully considered. The potential value of any measurement of hospital-acquired infection that uses routinely documented data will increase as clinical case notes become more structured and computerised hospital information systems become more reliable.

Evaluation of the effectiveness of infection control care needs to be explicit within care processes. The rising need for clinical governance, demands for quality in the NHS, global issues of antibiotic resistance, increasing costs of healthcare, theory-practice gap, involvement of consumers, rights of consumers, demonstration of high quality care, economics of quality care. Researchers have circled this issue, media attention on hospital infection rises and falls. The question posed is why can't we use current information to support practice developments? A system which is outcomes-focused with measurement of risk factors and processes that is incorporated within a practical system with low costs and high impact on behaviour would seem to be favoured in the short-term and could be integrated within hospital information systems.

This research explored the potential for improving nursing practice of effective infection control. During the research a new, practical, and potentially cheaper, way to audit infection outcome in a UK setting was developed. Measurement of patient outcome was achieved using systematic, objective data collection, with data-feedback to staff. Overall the package developed in this research

- provided infection control information & education
- facilitated structured infection control risk assessment
- allowed nursing documentation of infection control care
- facilitated documentation of infection control care & outcomes of care
- provided an evidence-based protocol for infection control in the ICU
- promoted ownership of infection control practice developments
- highlighted local infection control issues
- provided improved information to empower nurses' decisions & actions

The package developed was responsive to local needs, resulted in improved clinical information and development of a comprehensive self-contained quality assurance and audit programme which met the need to demonstrate high quality of care within the overall theme of clinical governance. It was feasible to implement this approach within the complex clinical focus of intensive care. The methods, documentation and educational components of this programme should be generalisable to other clinical areas. With appropriate support, adopting the model of managed change through action research the system developed within this research could be adapted by others facing similar difficulties in determining priorities for monitoring and controlling endemic hospital-acquired infections within limited resources.

Conclusions

Current low levels of compliance with recommended infection control in the Intensive Care Unit are alarming. At the very least, acquired infections complicate a patient's recovery, increase discomfort and prolong hospital stay. At worst, they are a major contributory factor causing death in critically ill patients. In all cases hospital-acquired infection reduces quality of care, quality of recovery, and has possible consequences for the patient's present and future quality of life. Infection control is too often regarded as an optional extra activity of care. There was a need to effect change in clinical infection control practice whilst at the same time developing a quality assurance system which embraced current research and sought to link infection control behaviour to patient outcome and resource usage.

The nature of the work in intensive care means that shared contact occurs between health professionals and patients. This inevitably means that transmission of resident and transient organisms from the hands of staff are more likely to occur unless strict attention is paid to effective infection control. Lack of appropriate education in applied microbiology appears to be hindering the provision of a safe environment in the intensive care unit. The nurse's perception of the problem of hospital-acquired infection and the importance of microbiology will be influenced by knowledge of the scale of the problem within their own wards and units. This knowledge is vital in order to motivate an individual's application of appropriate knowledge to effective nursing practice. Nurses should be conscious of their present ability and responsibility to influence changes in attitudes of the healthcare team

towards effective researched-based infection control practices. As technology advances and threatens to dominate the intensive care unit, nurses should seek clear definitions of their nursing role.

This thesis argues that responsibility for infection control should be placed centrally to the role of every nurse. Other issues that fall directly in the realm and responsibility of nursing care and for which there are current difficulties in provision of core standards are patient nutrition, pressure area care, wound care, patient safety and communication. Key questions which might be posed in considering the lack of progress in delivery of effective and efficient nursing care are – what is what is a nurse and what is nursing if we are failing to deliver the most basic standards of care? Motivation is the result of internal and external factors. Internal motivators can be influenced, but not controlled, while external motivators can be created and controlled by others. In order to understand, predict and influence motivation of individuals and groups, knowledge of theories of motivation provide an insight into the motivating process. Organisations are composed of people vying with one another for power, failure to acquire power may result in a limited ability to have an impact on organisational politics, and lessen the success of motivating healthcare workers. Nurses could have a much greater role to play in preventing hospital-acquired infection. The nurse is in constant contact with the patient and is normally the co-ordinator of care and of clinical information. The critically ill patient is temporarily placed in a vulnerable condition, unable to meet his or her own health needs. The intensive care nurse, in close proximity to the patient, providing individualised continuous care, is well placed to act as advocate to the patient. To adopt this role requires nurses to be educated, motivated and facilitated to assist patients in transcending any barrier to their needs while they are undergoing health care (Witts 1992). By defining the health needs of the patient, and researching the contributions of nursing, nurses will move forward, stating effectively, what it is they do and why it makes a difference in the care of the critically ill patient.

With acute shortages of intensive care nurses with specialist skills there are arguments that some experienced ICU nursing staff could be replaced; technical staff could maintain medical equipment and the physical care role could be performed by health care assistants. This would leave skilled ICU nurses to

interpret data and make clinical decisions. Demographic changes and shortage of nurses have created new demands on the health care service and the call for more cost-effective use of resources. In discussing skill mix in nursing Gibbs *et al.* (1990) highlight that the *"skills and experience of nurses represents a valuable resource within nursing"*. Carr-Hill *et al.* (1992) examined links between skill-mix and outputs of nursing in terms of quality and outcome of care. They found that grade mix had an effect on quality of care, *" the quality of care was much better the higher the grade (and skill) of the nurses who provided it, but (that) the variation in the quality of care was reduced when higher graded staff worked in combination with lower graded staff".*

The psychosocial basis for change requires appropriate use of education and persuasion techniques. Health professionals need to clarify their roles, responsibilities, accountability and responsibility for their clinical practice. Improving information systems should heighten perception of the problem of endemic hospital-acquired infection, raise awareness of the potential for change and increase motivation to change. There is an immediate need for infection control mechanisms that utilise routinely collected clinical data and incorporate this within a risk management approach to endemic hospital-acquired infection, addressing cost and quality issues using an epidemiological approach. If this information were collated and analysed it could be incorporated within a collaborative, systematic approach to improving infection control. Development of appropriate feedback mechanisms will provide problem-focused, outcomes-orientated clinical information. This would establish the healthcare system's responsibility for improved infection control action. Information as research evidence, education or clinical information needs to be transformed into professional knowledge. This knowledge needs to be incorporated within the management and organisation of infection control care.

Chapter Eight

Recommendations

The effective provision of a safe environment is of importance to patients, health staff and visitors. Hospitals will need to examine the problem in their own organisations, in order that high quality care is delivered cost-effectively within the context of clinical governance.

Improving information and information technology

Information use and re-use is a vital component of effective clinical care. All hospitals in the UK have computerised hospital information systems that contain patient and clinical information. Most ICUs will have more detailed clinical databases for routine collection of key items, particularly those who are involved in the Intensive Care National Audit and Research Study (ICNAR). This ICU-based data could provide most details of risk factors for infection as often this data includes number of days a patient requires endo-tracheal intubation and less often number of days of intra-vascular device use. The addition of four data fields within a computerised ICU database for the four parameters: stages of clinical signs and symptoms of infection, bacteriology results, antibiotic changes and medical diagnosis. Use of automated algorithmic decision process would allow measurement of patient outcome with a high degree of sensitively and specificity. Automated production of information including cumulative rates and accepted threshold levels for different categories of site-specific infections or increasing trends of specific bacteria cultured would allow full benefits of sensitive, rigorous monitoring with the immediacy of "flagging" of increasing trends of infection. Adjustment of infection outcome for risk as suggested by Haley (1995) would confidently place surveillance of infection on a scientific basis, but within the UK we are limited by resources and the availability of necessary information technology. Computerised positive bacteriology results for use in case-finding of potentially infected individuals would make a suitable cost-efficient approach to providing information on patterns of bacteria being cultured. This would act as a marker for the types of bacteria commonly associated with infections. This in turn would help to identify common causes of colonisation and infection. When this information is linked with both knowledge of aetiology and epidemiology of acquired infection, and knowledge of potential sources of infection, the route of transmission and the infection process health professional can adopt a ration approach to prevention.

Use of routinely collected clinical data

At present large quantities of data are collected in hospitals, but the emphasis has been on developing management information systems with some clinical information systems without the possibility of integration. Most of the clinical data remains unused and is collected in a way that makes analysis difficult. There is a need to disentangle the data to produce meaningful information. Documented evidence is necessary to demonstrate that care planning and action are based on individual risk assessment and elements of care that are planned are actually delivered and evaluated. There is an immediate need for infection control mechanisms that utilise routinely collected clinical data and incorporate this within a risk management approach to management and control of endemic hospital-acquired infection using an epidemiological approach. Collation of routine data with appropriate feedback mechanisms would provide improved clinical information systems, which are problem-focused, clinically-orientated & outcomes focused and the healthcare system can acknowledge the responsibility for appropriate action.

Clinical governance in infection control

The costs of poor infection control practices in the health service are hidden. Further investigations will require cost-benefit analysis studies conducted in the UK in order to assess the potential to improve quality and reduce costs. Tingle (1997b) drew attention to the Audit Commission's report on co-ordinating care for the elderly that found serious lapses in the way pressure sore prevention was carried out. The article discussed recent legal cases and concluded that most pressure area complaints and cases could have been easily avoided at minimum or no expense. The same assumption could be made for the prevention & management of infection acquired in hospital, particularly so for the high extrinsic risks that intensive care exposes patients to who, already have a high intrinsic risk for acquired infection. It will become increasingly important to examine the provision of health services and include the some indication of patient outcome in relation to hospital-acquired infection as a necessary component of clinical audit and clinical governance. Risk management, clinical audit and demonstrating evidence of best practice in relation to infection control through improved documentation are essential components to raise the quality of care which would, if managed effectively, improve information systems and potentially reduce the cost of health care provision.

Prioritise resources and infection control activity

Patients requiring intensive therapy are at high risk of infection and many of these infections are caused by poor techniques and are preventable. Work in an intensive care unit places high emotional, physical and professional demands on nurses. There is a multiplicity of intrinsic and extrinsic factors affecting the nurse working in the intensive care unit. These, in turn, influence perception of the problem of hospital-acquired infection. Because attitudes and values are leamt, they have the potential to be influenced, often in an automatic, unconscious fashion. As a result strategies for improving clinical practice can be directed towards cognitive and behavioural components of individuals working in the intensive care unit. Problems of infection control in the intensive care unit should be analysed using a pragmatic approach, having first gained some understanding of theories of individual and organisational behaviour. The social sciences can provide a framework to allow an understanding of human behaviour and these theories can be applied to the present arrangements for control of infection in the intensive care unit.

Clarity of roles, responsibility and accountability for effective infection control

The nurse, in close proximity to the patient is ideally placed to adopt a primary role in preventing infection. If nurses do not possess an adequate knowledge of the principles of microbiology or infection control, or do not apply this knowledge in clinical practice, and the culture of the organisation is such that inhibits creativity or enquiry, the knowledge for effective prevention of infection remains in the hands of a minority of specialists. If nurses can accept that hospital-acquired infection in British hospitals can be reduced by improving clinical practice, this means accepting the care we give is less than optimal. It then becomes the nurse's responsibility to become a "guardian" of the patient's microbial environment. In the light of current research indicating the risks of hospital-acquired infection to patients, there is need for every patient admitted to have their infection status assessed and appropriate action taken. The control of infection is a responsibility shared by all disciplines working in the NHS, although as a result of their regular "hands on" contact with patients, nurses stand in the front line. In order to identify the need to advance personal knowledge of effective infection control, when social pressures to maintain the present status quo are high, the nurse must be aware of the importance of acquiring a sound knowledge base appropriate to patient needs and applying the principles of microbiology in nursing practice to all stages of the nursing process documentation.

Research

Development, implementation and evaluation in this study took place using one external facilitator who then facilitated internal facilitators in each ICU. Considerations need to be made as to the potential impact that have been made if additional resources were available. A larger study is required to establish the effectiveness of this method. Research questions which might be posed are:

- how can we routinely collect endemic infection rates in the UK?
- who are the best people to collect the data?
- what impact does this have on ownership and practice development?
- does this increase potential for changing behaviour?
- does this impact on patient outcome?
- how would nurses at the bedside compare with a dedicated auditor?
- how does this impact on communication?
- how does this impact on service delivery and organisation?
- how does this impact on resource usage?

Infection control is generally taught as microbiology and not infection control as applied to practice. Nursing lecturers find infection control difficult to teach and nursing students find it difficult to learn. It would appear that the teaching and learning styles being used are not conducive to effective uptake of information and transfer of knowledge. There are barriers to implementing effective infection control practice and researchers have shown that key elements of motivation are intrinsic to effective infection control but that health care professionals show resistance to educational programmes. The nursing discipline is now actively seeking opportunities to improve clinical practice. However, nursing leaders have professed that a large gap exists between research-based knowledge and its implementation in the practice setting. There is a need for the biological sciences to be taught as core subjects in the education of nurses in order that they practice nursing care efficiently and effectively. The relationships between theory and practice needs further exploration. Key questions to be addressed through educational research are: what is taught to students (by whom, when, where, what, how and why)? Does the curriculum fit the purpose of the education? Is the information taken up and assimilated by students? How is this done? What changes are made? If information is received and internalised, how is this transferred into knowledge? How is this knowledge

transferred into practice, what hinders effective practice? Did the student ever know? How is knowledge transferred to clinical skills? How is this evaluated? How is basic knowledge built on in practice? What is the role of preceptors, mentors and clinical supervisors? What is the role of managers, chief executives or patients?

The most powerful change that could impact on standards of infection control is that of nursing practice development in infection control. This requires changes in health professionals, services and organisations. Researchers have effectively shown that key elements of motivation are intrinsic to effective infection control but that health care professionals show resistance to educational programme. Research should consider why healthcare professionals do not comply with basic standards of hygiene: was it ever taught? was it taught and inappropriate teaching styles used? was it taught and forgotten? was it taught and couldn't be put in practice? was it taught, internalised and occasionally forgotten? do healthcare professionals consciously omit infection control activities? Considering the increasing pressures on nurses: high workloads; reduced staffing; and low morale, further practice developments need to be facilitated and monitored through a central process involving experts from clinical practice, infection control, research, and change management. Further research is required into methods of effective dissemination which will ensure dissemination activities are assessed against certain outcomes such as knowledge, beliefs and attitudes:

> *"The ultimate challenge is to develop an empirical basis for choosing interventions in the face of specific barriers to evidence based practice, requiring both quantitative and qualitative methods to judge" [...], "not just the effectiveness of interventions, but gain an understanding of the process of professional behaviour change and greater insight is needed into the personal skills and attributes that influence the effectiveness of individuals involved in changing behaviour"*
>
> NHS Centre for Reviews and Dissemination 1999

Appendix I

Research Development

Appendix I, Table 1 Case definitions: clinical signs and symptoms for each site-specific HAI

Site-specific HAI	Clinical indicators >48 hours after admission
Lower Respiratory Tract Infection (LRTI)	One or more of the following; - presence of purulent chest secretions. - presence of new radiological changes, consolidation, new or progressive Infiltrate, not explained by a previously diagnosed disease. - evidence of respiratory compromise, e.g. deterioration of blood gas measurements or increasing difficulty in adequate lung ventilation.
Surgical Wound Infection (SWI) minor wound infection moderate wound infection severe wound infection	"ASEPSIS" score combining individual clinical indicators of surgical wound infection wound score 21 - 30 wound score 31 - 40 wound score > 40
Urinary Tract Infection (UTI)	In the absence of sample contamination - presence of micro-organisms (>10^5 cfu.) in one or more specimens of urine with no more than two species of micro-organism.
Blood Stream infection (BSI)	In the absence of sample contamination - one or more positive blood cultures obtained from a patient with IV therapy and clinical manifestations of septicaemia (pyrexia >38^0 C or hypotension) with no other apparent source of sepsis

Appendix I, Table 2 **Rules for determining patient outcome for site-specific HAI**

Step One **Identifying Documented Outcome Indicators**

For each site-specific infection being measured, documented clinical indicators for infection were collected in four parameters

a) Documented clinical signs and symptoms of site specific infection (see Table I);
b) Documented positive bacteriology culture obtained more than 48 hours after admission to hospital;
c) Documented new or changed therapeutic antibiotic prescription which obviously relates to category a or b; or
d) Documented medical diagnosis of site specific infection.

Step Two **Combining clinical indicators for infection to determine patient outcome**

For each site-specific infection being measured, documented clinical indicators were combined to determined patient outcome.

A positive recording was made when there was documented evidence of ;

either i.) a written medical diagnosis of a site-specific infection (parameter d)

and/or, ii.) two or more categories of outcome indicators (parameters a, b or c)

as follows:

If	a and b	were	positive;	or
	a and c	were	positive;	or
	b and c	were	positive;	or
	a and b and c	were	positive;	or
	d	was	positive,	
	then	hospital-acquired infection was recorded as positive,		
	otherwise,	hospital-acquired infection was recorded as negative		

Appendix I, Table 3 Summary of study group outcome: average trends over time all wards

Ward		Date	Study Group	Infected Patients	HAIs		LRTI		SWI		UTI		BSI	
					(n)	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)
A		Jul, Aug Sep 92	37	18.9 %	(7)	27.0 %	(10)	13.5 %	(5)	8.1 %	(3)	5.4 %	(2)	0.0%	(0)
B		Jul, Aug Sep 92	131	20.6 %	(27)	30.5 %	(40)	12.2 %	(16)	9.9 %	(13)	7.6 %	(10)	0.8%	(1)
C	pilot	Jul, Aug Sep 92	112	17.9 %	(20)	25.9 %	(29)	13.4 %	(15)	6.3 %	(7)	3.6 %	(4)	2.7%	(3)
D	control	Jul, Aug Sep 92	83	26.5 %	(22)	38.6 %	(32)	16.9 %	(14)	10.8 %	(9)	6.0 %	(5)	4.8%	(4)
			363	20.9 %	(76)	30.6 %	(111)	13.8 %	(50)	8.8 %	(32)	5.8 %	(21)	2.2%	(8)
A		Jan, Feb, Mar 93	140	10.0 %	(14)	11.4 %	(16)	4.3 %	(6)	5.7 %	(8)	1.4 %	(2)	0.0%	(0)
B		Jan, Feb, Mar 93	144	9.7 %	(14)	11.1 %	(16)	3.5 %	(5)	5.6 %	(8)	2.1 %	(3)	0.0%	(0)
C	pilot	Jan, Feb, Mar 93	73	13.7 %	(10)	17.8 %	(13)	12.3 %	(9)	2.7 %	(2)	1.4 %	(1)	1.4%	(1)
D	control +	Jan, Feb, Mar 93	86	10.5 %	(9)	12.8 %	(11)	5.8 %	(5)	4.7 %	(4)	1.2 %	(1)	1.2%	(1)
			443	10.6 %	(47)	12.6 %	(56)	5.6 %	(25)	5.0 %	(22)	1.6 %	(7)	0.5%	(2)
A		Jul, Aug, Sep 93	106	10%	(11)	11%	(12)	5.7 %	(6)	5.7 %	(6)	0.0 %	(0)	0.0%	(0)
B		Jul, Aug, Sep 93	95	12%	(11)	15%	(14)	3.2 %	(3)	6.3 %	(6)	4.2 %	(4)	1.1%	(1)
C	pilot	Jul, Aug, Sep 93	76	11%	(8)	13%	(10)	6.6 %	(5)	4.0 %	(3)	2.6 %	(2)	0.0%	(0)
D	control	Jul, Aug, Sep 93	80	23%	(18)	25%	(20)	6.3 %	(5)	12.5 %	(10)	3.8 %	(3)	2.5%	(2)
			357	13%	(48)	16%	(56)	5.3 %	(19)	7.0 %	(25)	2.5 %	(9)	0.8%	(3)

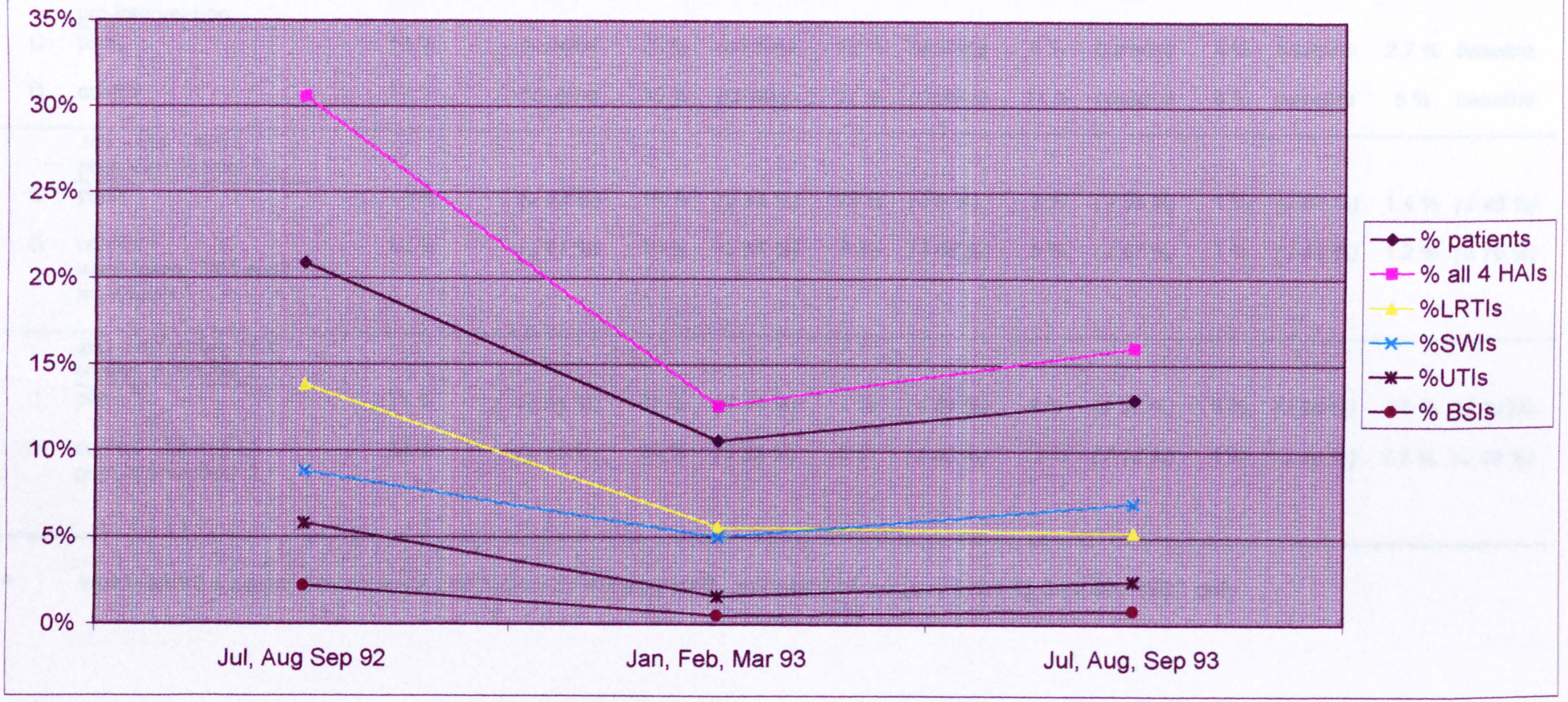
\+ ward-based surgical wound audit conducted by nursing staff on behalf of surgeons during January 1993 only

Appendix I, Graph 1

Effect of surveillance: all wards

Proportion of patients, % of all four HAIs and % individual HAIs

January 1992 to September 1993



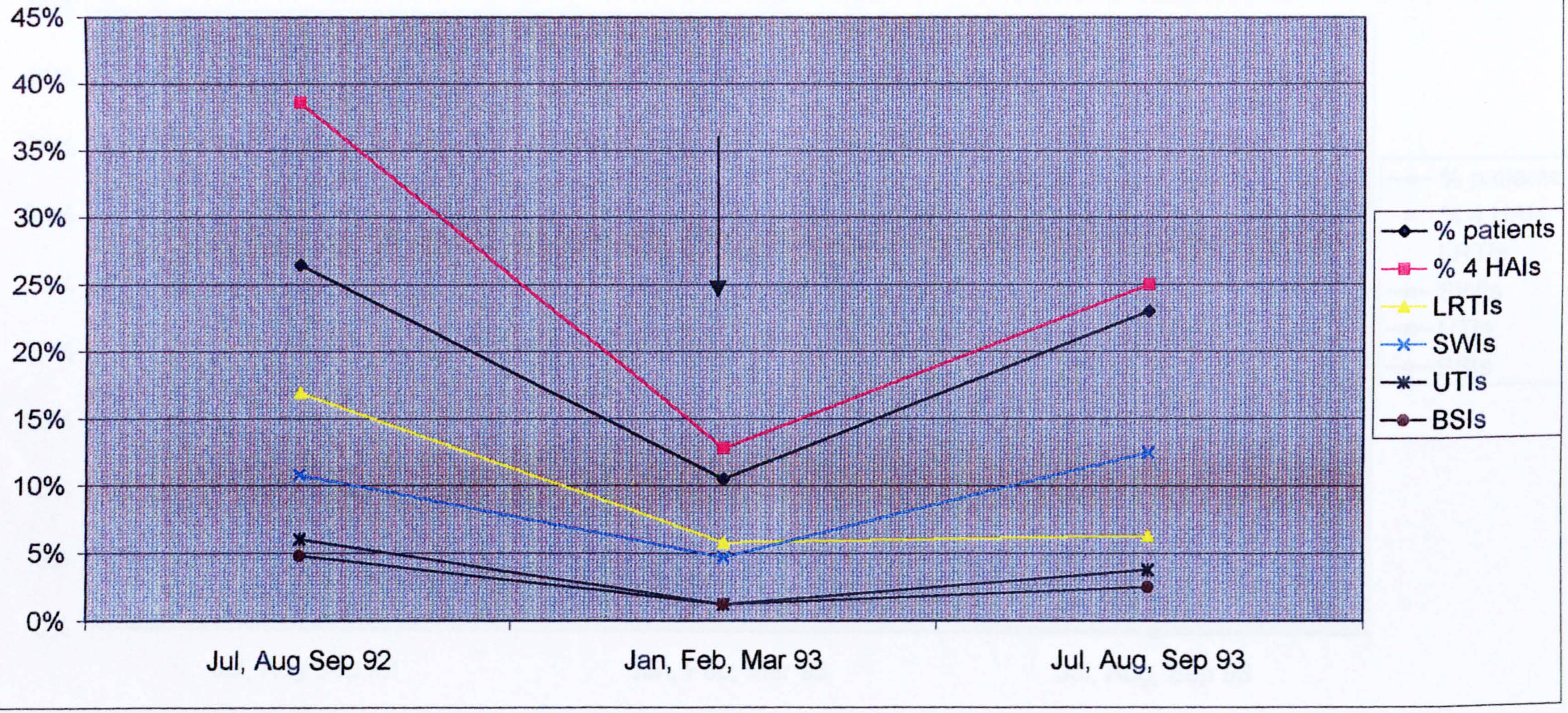
Appendix I, Table 4 Summary of patient outcome for the matched wards (C and D) study group- baseline and post-intervention reductions

Ward		% Infected Patients		% HAIs		% LRTI		% SWI		% UTI		% BSI	
	Jul –Sep 1992 pre-intervention												
C	pilot	18 %	*baseline*	26 %	*baseline*	13 %	*baseline*	6 %	*baseline*	4 %	*baseline*	2.7 %	*baseline*
D	control	27 %	*baseline*	39 %	*baseline*	17 %	*baseline*	11 %	*baseline*	6 %	*baseline*	5 %	*baseline*
	Jan – Mar 1993 post-intervention :1												
C	pilot	14 %	*(↓23 %)*	18 %	*(↓34 %)*	12 %	*(↓8 %)*	3 %	*(↓56 %)*	1 %	*(↓61 %)*	1.4 %	*(↓49 %)*
D	control + *ward-based SWI audit in January*	10 %	*(↓61 %)*	13 %	*(↓67 %)*	6 %	*(↓66 %)*	5 %	*(↓57 %)*	1 %	*(↓81 %)*	1.2 %	*(↓76 %)*
	July-September 1993 post-intervention :2												
C	pilot	11 %	*(↓41 %)*	13 %	*(↓49 %)*	7 %	*(↓51 %)*	4 %	*(↓37 %)*	3 %	*(↓26 %)*	0.0 %	*(↓100%)*
D	control : Jul-Sep 93 post-intervention :2	22 %	*(↓15 %)*	25 %	*(↓35 %)*	6 %	*(↓63 %)*	13 %	*(↑15 %)*	4 %	*(↓38 %)*	2.5 %	*(↓48 %)*

\+ ward-based surgical wound audit conducted by nursing staff on behalf of surgeons during January 1993 only

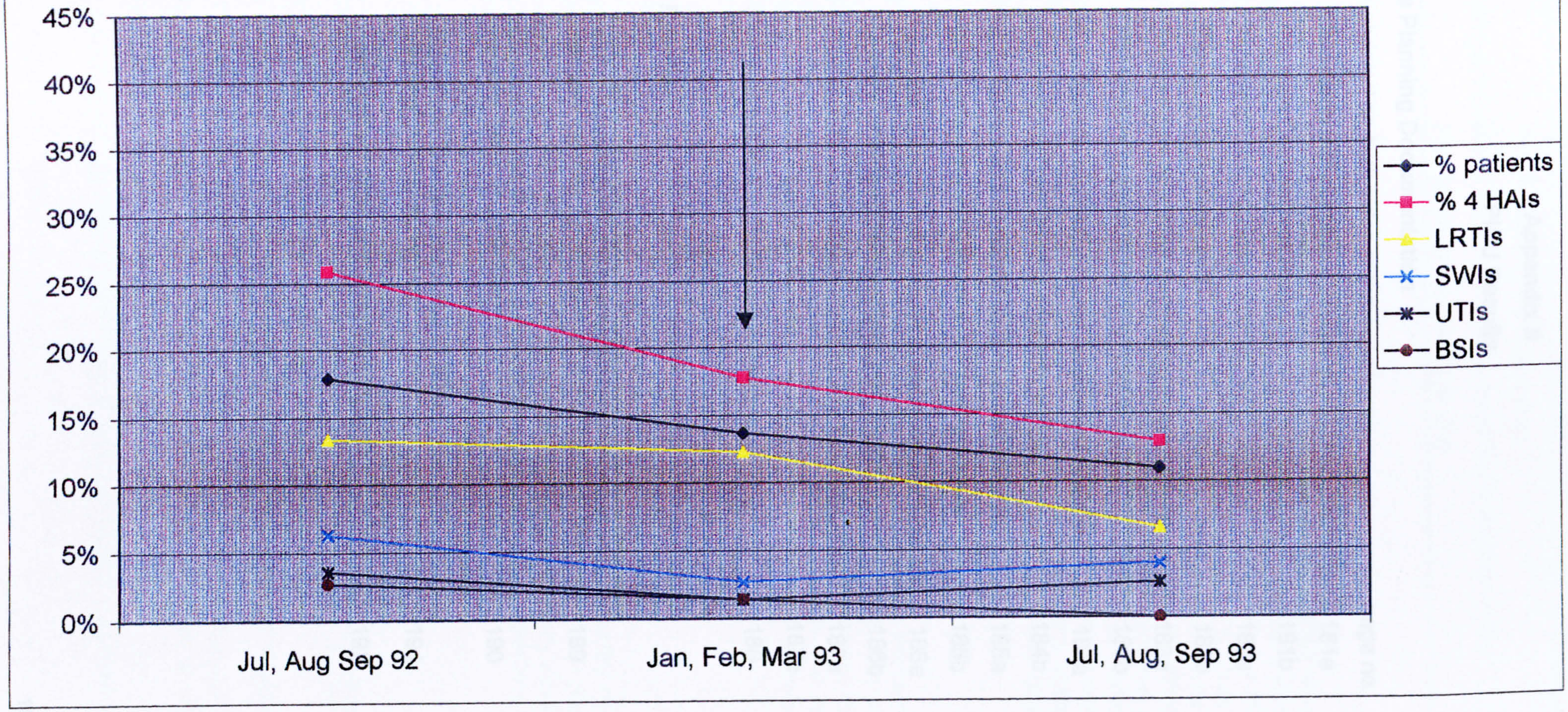
Appendix I, Graph 3

Impact of the one month surveillance of surgical wound infection on the control ward
(January 1992)
Proportion of patients, % of all four HAIs and % individual HAIs



Appendix I, Graph 2

Impact of surveillance on the pilot ward
(January 1992 to September 1993)
Proportion of patients, % of all four HAIs and % individual HAIs



Appendix II

PICU Results

Audit and Care Planning Documentation

PICU Audit Results

Ph.D. Research Programme

Developing prospective audit of hospital-acquired infection in the Paediatric Intensive Care Unit

Hospital-acquired Infection: What's the problem?

Healthy people carry millions of bacteria on the surface of their body, on their skin, in their noses, mouths, respiratory tract, genito-urinary tract and bowel. If bacteria enter a normally sterile part of the body of a healthy individual, the body has various mechanisms for natural resistance to these bacteria and infection does not usually occur. When people enter hospital as patients they may have increased risks for developing an infection such as; severe underlying illness, poor general health or a condition which requires invasive treatment or therapy. In these circumstances **the patient's own normal resistance to infection can be decreased.** The risks of infection are further increased by any circumstance in which patients require intensive care. **Infections acquired in hospital are often caused by patient's own bacteria (endogenous), but can also result from cross-infection** (exogenous) and can be caused by bacteria from other patients, staff and equipment.

The problem of hospital-acquired infection is well recognised in hospitals world-wide, but up to date, no-one really knows the best way to reduce it over the long term. Retrospective audit of patient infection rates and staff education programmes have been successful in reducing hospital-acquired infection in some hospitals, but these intensive programmes require additional staff, are time consuming and expensive. Therefore they are not currently recommended.

The Research Programme

The research aims to examine **what potential there is to improve the quality of our care.** It will investigate the feasibility of including aspects of infection control in routine documentation and if so, whether this aids risk assessment and care delivery aimed at preventing infection. This research will be supported by an educational programme with priorities set as a result of the audit.

The Research Questions

1. Can patient risk factors and outcome measures for hospital-acquired infection be identified and collected from routinely collected data items?
2. Can these data items be integrated within a practical audit tool for measuring incidence of hospital-acquired infection?
3. Is it feasible to incorporate this audit tool within routine documentation of clinical care in a systematic, cost-efficient way?
4. If so, what impact would this have on standards of care and patient outcome?

Standard Infection Control Care Plan

Problem: **Potential risk of acquiring an infection**

Goal of care

- Prevention of new infection
- Early detection of developing infection
- Control potential cross infection

Care Plan

1. Assess the child's risks of acquiring infection and identify individual care needs.

2. Plan care to meet these care needs.

3. **Use Universal Precautions for all children at all times**

4. Monitor the child's vital signs, temperature, pulse and blood pressure for early detection of the signs of infection. Report all changes indicative of developing infection.

5. Monitor all invasive medical devices e.g., endotracheal tubes, intravenous cannulae, urinary catheters and surgical wounds, body fluid drainage and faeces for any signs and symptoms of possible, probable or actual infection.

   Report and document any changes indicative of developing infection.

6. Safely collect, label and transport any bacteriology specimens as requested. Ensure the request form is correctly filled in.
   Record all swabs taken/results in the patient care plan.

7. Actively prevent infection by correct use of hand washing/alcohol rub and an aseptic technique for the insertion and care of medical invasive devices and surgical wounds. Use a clean technique and disposable non-sterile gloves for respiratory therapy. Clean and store nebulisers dry between use.

8. Change filtered IV giving sets every 96 hours, infusion bags and IV preparations every 24 hours and IV cannulas as clinically indicated.

9. Evaluate the patients infection status, at least daily, document the presence of an infection and modify care appropriate to the current infection status.

10. Report to or seek advice from the Infection Control Manager regarding a patient's risk of acquiring or transmitting infection if you are unsure about the appropriate precautions that should be taken.

11. Comply with *"hospital"* (Universal Precautions and Disinfection policy) and local (PICU) Infection Control policies, the Health and Safety At Work Act and COSHH regulations.

12. Provide the child and/or the child's parents and family with education and information appropriate to their needs and stress how they can contribute to reducing the risks of infection in hospital and at home.

Research Programme (PICU)
Developing prospective audit of hospital-acquired infection

Section	Instructions
• Patient Risk Assessment • Identification of Care Needs	• Document risk factors on admission and on first placement of invasive medical devices and first major surgical procedure. • Assess and record care needs once only within first 24 hours
• **Shift by shift assessment of:** - invasive devices, treatment and therapy - child's infection status	• **At the end of each shift** - using the available codes, assess and document the current status of each medical invasive device and surgical wound. - using standard criteria, evaluate and document child's infection status
• **Summary of child's outcome**	• **Document once only on discharge**
• **Reference section** - HAI Research Background	Patient name . . . . Fix Patient label here ↓
• **Additional Information** - Universal Precautions - Hand hygiene in the ICU	

Follow these five stages for all children admitted to PICU

1. On a child's admission — Complete section 1
2. Once daily at 12 midnight — Complete section 2
3. On the child's discharge/transfer — Complete section 3
4. Please place the completed research file and its contents in box file A labelled:

   "Completed HAI research files"

5. Replace with a new research file from box file B labelled:

   "New HAI research files".

Please don't forget to include the child's name on the forms!

Do not send this file with the patient's hospital notes.

This research file must remain on PICU for data collection and analysis.

PICU PATIENT RISK STATUS

Prior to admission

Respiratory impairment	Y	N	*Diabetes*	Y	N
Immune status impaired	Y	N	*Chemotherapy*	Y	N
Steroid therapy	Y	N	*Other .....*		

Previous therapy

Previous hospital stay	. . . . . **days**		*Previous ICU stay*	. . . . . **days**	
Previous Infection	Y	N	1	2	3	>3
Previous antibiotics	Y	N	1	2	3	>3

On admission

PRISM score **(first 24 hours)** . . . . . *TISS score* **(first 24 hours)** . . . .

Nutritional status impaired Y N

Physical measures **Height . . . . . .Weight . . . . . .BMI . . . . . .**

Skin fold thickness **Triceps . . . . . .**

Arm circumference **Mid-upper arm . . . . . .Mid arm . . . . . .**

Laboratory data **Se Albumen . . . . . Se Urea . . . . . .**

Lymphocytes . . . . .

Medical device related risk factors

Respiratory support	**ET intubation**	Y	N	**date intubated**	..../ ..../ ....
	ET ventilation	Y	N	**date ventilated**	..../ ..../ ....
IV therapy	**Peripheral line**	Y	N	**date inserted**	..../ ..../ ....
	Arterial line	Y	N	**date inserted**	..../ ..../ ....
	CVP line	Y	N	**date inserted**	..../ ..../ ....
Others	**ICP monitor**	Y	N	**date inserted**	..../ ..../ ....
	PD	Y	N	**date inserted**	..../ ..../ ....
	Urinary catheter	Y	N	**date inserted**	..../ ..../ ....

Surgical Wound Related

Pre-op stay >= 7 days before surgery Y N

Major abdominal surgery	Y	N	*Major Thoracic surgery*	Y	N
Wound Classification	**Clean**	[ ]	**Clean contaminated**	[ ]
	Contaminated	[ ]	**Dirty**	[ ]

ASSESSMENT OF PATIENT CARE NEEDS

a) The child/parents are able to meet the child's own safety & hygiene needs

Y N

b) The child/parents need assistance/intervention as follows;

i) education/ information [ ]

ii) minimal assistance [ ]

iii) partial assistance [ ]

iv) total dependence on care [ ]

PICU Audit and Care Planning Documentation
Chart 5

Date	Day	Highest core temp	Lowest core temp	No of times core T. > 38	No of times core T. < 35	Bacteriology specimens collected and sent for culture	Bacteriology results received	Infection suspected	Sign
		Previous 24 hours	*Previous 24 hours*	*Previous 24 hours*	*Previous 24 hours*	*SP : sputum or bronchial aspirate* *BL : Blood* *SW : surgical wound swab or fluid* *CSU : catheter specimen of urine* *Other : record other specimens*	*SP : sputum or bronchial aspirate* *BL : Blood* *SW : surgical wound swab or fluid* *CSU : catheter specimen of urine* *Other : record other specimens*	*LRTI: Lower respiratory tract infection* *BSI: Blood stream infection* *SWI: Surgical Wound Infection* *UTI : Urinary Tract Infection*	
	1					SP BL SW CSU None Other	SP BL SW CSU None Other	YES LRTI BSI SWI UTI NO Other	
	2					SP BL SW CSU None Other	SP BL SW CSU None Other	YES LRTI BSI SWI UTI NO Other	
	3					SP BL SW CSU None Other	SP BL SW CSU None Other	YES LRTI BSI SWI UTI NO Other	
	4					SP BL SW CSU None Other	SP BL SW CSU None Other	YES LRTI BSI SWI UTI NO Other	
	5					SP BL SW CSU None Other	SP BL SW CSU None Other	YES LRTI BSI SWI UTI NO Other	
	6					SP BL SW CSU None Other	SP BL SW CSU None Other	YES LRTI BSI SWI UTI NO Other	
	7					SP BL SW CSU None Other	SP BL SW CSU None Other	YES LRTI BSI SWI UTI NO Other	
	8					SP BL SW CSU None Other	SP BL SW CSU None Other	YES LRTI BSI SWI UTI NO Other	
	9					SP BL SW CSU None Other	SP BL SW CSU None Other	YES LRTI BSI SWI UTI NO Other	
	10					SP BL SW CSU None Other	SP BL SW CSU None Other	YES LRTI BSI SWI UTI NO Other	

Fix patient label here ↓

REFERENCE CODING
RESPIRATORY SUPPORT AND RELATED INFECTION STATUS

TABLE I ET TUBE STATUS

ET tube status	Record
ET tube inserted	I
ET tube remains in situ	Y
ET tube removed	X
ET tube changed	C
No ET tube in place	N

TABLE II ASSESSMENT OF RESPIRATORY INFECTION STATUS

Stage	General description	Guidelines for coding respiratory clinical signs and symptoms *Consider which category best matches your patient's infection status*
Stage 0	**No infection**	None
Stage 1	**Possible pre-infectious stage**	a) Increase in volume of sputum
Stage 2	**Probable infection** *Unconfirmed diagnosis of general respiratory infection*	a) Increasing volumes of sputum and b) Purulent chest secretions (yellow/green/brown)
Stage 3	**Actual infection** Lower Respiratory Tract Infection (LRTI)	a) Presence of purulent chest secretions and b) Presence of new radiological changes, consolidation, new or progressive infiltrate, not explained by a previously diagnosed disease and/or c) Evidence of respiratory compromise, e.g. deterioration of blood gas measurements or increasing difficulty in adequate lung ventilation.

PICU Audit and Care Planning Documentation
Chart 7

	INTERVENTION			EVALUATION				PATIENT OUTCOME
Date	ICU Day	ET tube	Nebulised medication	Clinical signs symptoms of lower respiratory tract infection	Positive bacteriology of sputum or bronchial aspirate	Antibiotic prescription for LRTI	Medical (written) diagnosis of LRTI	LRTI?
Record interventions and evaluation on a daily basis unless interventions or evaluations change		*Record device related status (See Table I above)*	*Record Y or N*	*Record 0, 1, 2 or 3 (See Table II above)*	*Record Y or N*	*Record Y or N*	*Record Y or N*	*Record Y or N*
	1	I Y X C N	Y N	0 1 2 3	Y N	Y N	Y N	Y N
	2	I Y X C N	Y N	0 1 2 3	Y N	Y N	Y N	Y N
	3	I Y X C N	Y N	0 1 2 3	Y N	Y N	Y N	Y N
	4	I Y X C N	Y N	0 1 2 3	Y N	Y N	Y N	Y N
	5	I Y X C N	Y N	0 1 2 3	Y N	Y N	Y N	Y N
	6	I Y X C N	Y N	0 1 2 3	Y N	Y N	Y N	Y N
	7	I Y X C N	Y N	0 1 2 3	Y N	Y N	Y N	Y N
	8	I Y X C N	Y N	0 1 2 3	Y N	Y N	Y N	Y N

REFERENCE CODING INTRAVENOUS (IV) CATHETERS AND RELATED INFECTION STATUS

TABLE I IV DEVICE RELATED STATUS

IV device status	Code
IV device inserted	I
IV device remains in situ	Y
IV device removed	X
IV device changed	C
No IV device in place	N

TABLE II ASSESSMENT OF IV-RELATED INFECTION STATUS

Infection Status	General description	Guidelines for coding IV-catheter related clinical signs and symptoms *Consider which category best matches your patient's infection status*
Stage 0	**No infection** No signs and symptoms of IV catheter-related infection	None
Stage 1	**Possible pre-infectious stage** Early signs of possible adverse reactions to IV therapy May be a physiochemical (non-infectious) reaction	• Restricted blood flow through IV catheter • Blocked IV catheter • c) Haematoma
Stage 2	**Probable infection** Mild/moderate local local site related infection	• Erythema at the site of the IV insertion • Tenderness and pain • Swelling • Red, palpable vein chord • Pus at the IV insertion site • Positive bacteriology report of swab from skin around the IV insertion site
Stage 3	**Actual infection** **IV Catheter Associated Bacteraemia** Asymptomatic No signs of systemic, generalised IV catheter-related infection	**In the absence of sample contamination (see bacteriology report)** • Positive IV catheter tip culture (>=15cfu/ml) and Positive blood culture from one or more blood cultures obtained on the same occasion or • Positive blood culture from two or more blood cultures obtained on separate occasions

Date		Central IV lines		Peripheral	EVALUATION					OUTCOME
	ICU day	IV(c) no 1 Site:	IV (c) No 2 Site:	IV (p) no 1 Site:	Clinical signs symptoms of blood nfection	Positive bacteriology (Blood)	Antibiotic prescription for BSI	Medical (written) diagnosis of BSI	WCC	Bacteraemia (3) or Septicaemia (4)?
		Record status See Table I	*Record Status See Table I*	*Record Status See Table I*	*Record 0, 1, 2, 3 or 4 See Table I I above*	*Record Y or N*	*Record Y or N*	*Record Y or N*	*Record WCC*	*Use the algorithm to determine outcome*
	1	I Y X C N	I Y X C N	I Y X C N	0 1 2 3 4	Y N	Y N	Y N		Y 3 4 N
	2	I Y X C N	I Y X C N	I Y X C N	0 1 2 3 4	Y N	Y N	Y N		Y 3 4 N
	3	I Y X C N	I Y X C N	I Y X C N	0 1 2 3 4	Y N	Y N	Y N		Y 3 4 N
	4	I Y X C N	I Y X C N	I Y X C N	0 1 2 3 4	Y N	Y N	Y N		Y 3 4 N
	5	I Y X C N	I Y X C N	I Y X C N	0 1 2 3 4	Y N	Y N	Y N		Y 3 4 N
	6	I Y X C N	I Y X C N	I Y X C N	0 1 2 3 4	Y N	Y N	Y N		Y 3 4 N
	7	I Y X C N	I Y X C N	I Y X C N	0 1 2 3 4	Y N	Y N	Y N		Y 3 4 N
	8	I Y X C N	I Y X C N	I Y X C N	0 1 2 3 4	Y N	Y N	Y N		Y 3 4 N
	9	I Y X C N	I Y X C N	I Y X C N	0 1 2 3 4	Y N	Y N	Y N		Y 3 4 N
	10	I Y X C N	I Y X C N	I Y X C N	0 1 2 3 4	Y N	Y N	Y N		Y 3 4 N

TABLE II : CLASSIFICATION OF SURGICAL WOUNDS Page 7

Classification	Coding	Examples
Clean	**CL**	• Elective, primarily closed and undrained • Non-traumatic, uninfected • No inflammation encountered • No break in aseptic technique • Respiratory, alimentary, genito-urinary or oropharyngeal tracts **not entered**
Clean-contaminated	**CC**	Alimentary, respiratory or genito-urinary tracts entered under controlled conditions without any unusual contamination eg • Appendicectomy • Oropharynx entered • Vagina entered • Genitourinary tract entered in absence of • positive urine culture • Bilary Tract entered in absence of infected bile • Gastro-intestinal tract entered without evidence • of inflammation or infection • Minor break in surgical technique • Mechanical drainage
Contaminated	**CT**	• Open fresh traumatic wounds • Gross spillage from gastrointestinal tract • Entrance of genitourinary or bilary tracts in presence of infected urine or bile • Major break in surgical technique • Incisions in which acute non-purulent inflammation is present eg Gastro-intestinal tract entered with evidence of inflammation/infection
Dirty and Infected	**D**	Traumatic wound with retained devitalised tissue, foreign bodies, faecal contamination, or delayed treatment, or from a dirty source

REFERENCE TABLE III : The ASEPSIS Wound Scoring System
Instructions - to evaluate surgical wound infection status, add the scores from table IIIa to those from table IIIb. Interpret the score in Table IIIc and record the daily surgical wound infection status (0, 1, 2, 3 or 4) on page 4

Table IIIa PRIMARY ASSESSMENT OF WOUND INFECTION

Wound Characteristic	Proportion of Wound Affected (%)					
	0	< 20	20 - 39	40 - 59	60 - 79	> 80
Serous exudate	0	1	2	3	4	5
Erythema	0	1	2	3	4	5
Purulent exudate	0	1	4	6	8	10
Separation of deep tissue	0	2	4	6	8	10

Table IIIb Additional Points to be added to the ASEPSIS wound score

Additional Treatment as a result of a wound infection	Points
New or changed antibiotics	10
Drainage of pus under local anaesthesia	5
Debridement of wound under general anaesthesia	10
Serous Discharge	5
Erythema	5
Purulent exudate	10
Separation of deep tissues	10
Isolation of bacteria	10
GITU stay prolonged (>14 days) as a result of wound infection	5

Table IIIc Interpretation of ASEPSIS score/infection status

ASEPSIS wound score	Description	Infection status
0 - 10	satisfactory healing	0
11 - 20	disturbance of healing	1
21 - 30	minor wound infection	2
31 - 40	moderate wound infection	3
> 40	severe wound infection	4

	INTERVENTIONS						EVALUATION				PATIENT OUTCOME
Date	ICU day	Wound Classification	Duration of operation > 2 hours	Drains	Dressing	Peri-operative antibiotic prophylaxis	Clinical signs/symptoms of SWI	Positive bacteriology (pus/wound swab/drain fluid)	Antibiotics for SWI or, extension of prophylactic antibiotics for SWI	Medical (written) diagnosis of SWI	E. SWI?
		See Table I above	*Record Y or N*	*Record number*	*Record Y or N*	*Record Y or N*	*Record ASEPSIS score See table II*	*Record Y or N*	*Record Y or N*	*Record Y or N*	*Record Y or N*
	1	CL CC CT D	Y N	1 2 3	Y N	Y N		Y N	Y N	Y N	Y N
	2	CL CC CT D	Y N	1 2 3	Y N	Y N		Y N	Y N	Y N	Y N
	3	CL CC CT D	Y N	1 2 3	Y N	Y N		Y N	Y N	Y N	Y N
	4	CL CC CT D	Y N	1 2 3	Y N	Y N		Y N	Y N	Y N	Y N
	5	CL CC CT D	Y N	1 2 3	Y N	Y N		Y N	Y N	Y N	Y N
	6	CL CC CT D	Y N	1 2 3	Y N	Y N		Y N	Y N	Y N	Y N
	7	CL CC CT D	Y N	1 2 3	Y N	Y N		Y N	Y N	Y N	Y N
	8	CL CC CT D	Y N	1 2 3	Y N	Y N		Y N	Y N	Y N	Y N
	9	CL CC CT D	Y N	1 2 3	Y N	Y N		Y N	Y N	Y N	Y N
	10	CL CC CT D	Y N	1 2 3	Y N	Y N		Y N	Y N	Y N	Y N

REFERENCE CODING: URINARY CATHETERISATION AND RELATED INFECTION STATUS

Table I Urinary drainage device status

Urinary drainage device status	Code
Device inserted	I
Device remains in situ	Y
Device removed	X
Device changed	C
No device in place	N

TABLE II ASSESSMENT OF URINARY CATHETER RELATED INFECTION STATUS

Stage	General Description	Guidelines for coding urinary catheter related clinical signs and symptoms
0	**No Infection**	None
1	**Possible Infection**	Any of the following; a) pain c) offensive smelling urine
2	**Probable Infection**	Any of the following; a) pain b) cloudy urine c) offensive smelling urine
3	**Actual Infection** Bacteriuria Asymptomatic (probable urinary colonisation)	a) presence of microorganisms in a catheter specimen of urine (>100, 000 cfu per ml) with no more than two species of microorganism without ant signs of systemic infection and b) repeated isolation of the same microorganism from subsequent urinary catheter specimens of urine with no more than two species of microorganism

	INTERVENTION			EVALUATION				PATIENT OUTCOME
Date	ICU day	Urinary Catheter	Record type of urinary catheter used	Clinical signs and symptoms of infection	Positive bacteriology (CSU)	Antibiotic prescription for UTI (stage 3/4)	Medical (written) diagnosis of UTI	Bacteriuria (3) or UTI (4)?
		Record status *See Table I above*	*Foley catheter (FC) or NG tube*	*Record 0, 1, 2, 3 or 4* *See Table II above*	*Record Y or N*	*Record Y or N*	*Record Y or N*	***Use the algorithm to determine patient outcome Record Y or N If yes circle stage 3 or 4***
	1	I Y X C N	FC NG	0 1 2 3 4	Y N	Y N	Y N	Y 3 4 N
	2	I Y X C N	FC NG	0 1 2 3 4	Y N	Y N	Y N	Y 3 4 N
	3	I Y X C N	FC NG	0 1 2 3 4	Y N	Y N	Y N	Y 3 4 N
	4	I Y X C N	FC NG	0 1 2 3 4	Y N	Y N	Y N	Y 3 4 N
	5	I Y X C N	FC NG	0 1 2 3 4	Y N	Y N	Y N	Y 3 4 N
	6	I Y X C N	FC NG	0 1 2 3 4	Y N	Y N	Y N	Y 3 4 N
	7	I Y X C N	FC NG	0 1 2 3 4	Y N	Y N	Y N	Y 3 4 N
	8	I Y X C N	FC NG	0 1 2 3 4	Y N	Y N	Y N	Y 3 4 N

SUMMARY OF PATIENT OUTCOME

Name of micro-organism cultured ?

Lower respiratory tract infection

Date: . . ./ . . ./ . . . Y N A B C D . . . . . .

Date: . . ./ . . ./ . . . Y N A B C D . . . . . .

Date: . . ./ . . ./ . . . Y N A B C D . . . . . .

IV-catheter related infection (Stage 3 Bacteraemia)

Date: . . ./ . . ./ . . . Y N A B C D . . . . . .

Date: . . ./ . . ./ . . . Y N A B C D . . . . . .

Date: . . ./ . . ./ . . . Y N A B C D . . . . . .

IV-catheter related infection (Stage 4 Septicaemia)

Date: . . ./ . . ./ . . . Y N A B C D . . . . . .

Date: . . ./ . . ./ . . . Y N A B C D . . . . . .

Date: . . ./ . . ./ . . . Y N A B C D . . . . . .

Surgical wound infection (ASEPSIS >20)

Date: . . ./ . . ./ . . . Y N A B C D . . . . . .

Date: . . ./ . . ./ . . . Y N A B C D . . . . . .

Urinary tract infection (Stage 3 : Bacteriuria)

Date: . . ./ . . ./ . . . Y N A B C D . . . . . .

Date: . . ./ . . ./ . . . Y N A B C D . . . . . .

Urinary tract infection (Stage 4 : Urinary Catheter-associated Infection)

Date: . . ./ . . ./ . . . Y N A B C D . . . . . .

Date: . . ./ . . ./ . . . Y N A B C D . . . . . .

Discharge/ transfer from PICU **Date:** . . ./ . . ./ . . .

Summary completed **Date:** . . ./ . . ./ . . .

Summary completed by: . . . . (name)

RESEARCH PROGRAMME PICU: BACKGROUND INFORMATION

Risk factors for the acquisition of hospital infection are dependent on the patient's individual characteristics, the type of healthcare provided and the hospital environment. The body's normal defences to infection are greatly reduced for the very young or very old patients who also have some underlying disease or condition which impairs the immune system.

Hospital-acquired infections cause distress, they increase pain and suffering experienced by patients (Glenister 1991). Acquiring an infection in hospital prolongs a patient's stay (Public Health Laboratory Service 1991), thus exposing patients to the added risk of further complications. This decreases the quality of healthcare experience and significantly raises the cost of patient care (French et al. 1991, Currie and Maynard 1989).

Poor hand hygiene in hospitals is regarded as the largest contributory factor for hospital-acquired infection (Larson 1988/1989). Generally, hand washing techniques are inadequate throughout all health professional groups (Casewell and Phillips 1977, Taylor 1978 (i), Taylor 1978 (ii), Sneddon 1990, Elliot 1989).

Each member of the healthcare team has a responsibility to reduce the risk of hospital-acquired infection to those patients in their care and must recognise the causes of infection and utilise a cost-effective, proactive approach to its prevention.

A recognised chain of events must always precede hospital-acquired infection. This includes a source of pathogenic microoganisms, a method of carriage, a means of spread, a vulnerable patient and a breach of the patient's natural defence to infection.

In understanding the nature of the risk of hospital-acquired infection and incorporating specific strategies into routine tasks, which aim to break the chain of infection, healthcare professionals can make a significant contribution to safeguarding the patient's immediate environment.

UNIVERSAL PRECAUTIONS

All health professionals have a responsibility to protect themselves and their patients from the considerable risks of hospital-acquired infection. Following some basic principles for controlling infection which include good hand hygiene practices and use of universal precautions will ensure that patients, staff and visitors are protected from the risks of hospital-acquired infection.

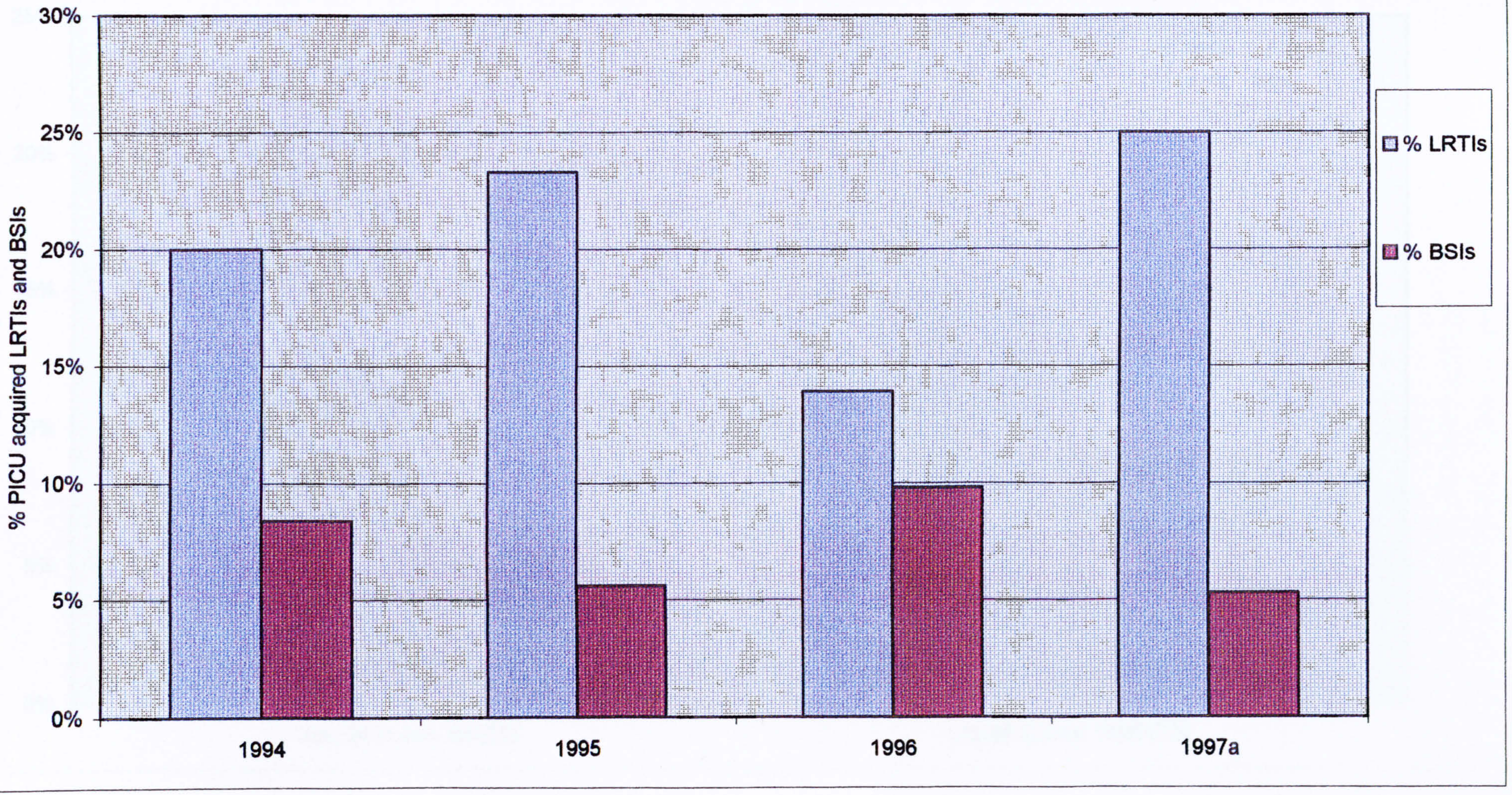
Appendix II Table 1
PICU Trends of LRTIs and BSIs by month for PICU patients staying >72 hours and all admissions
January 1994 - June 1997

	1994				Patients	1995				Patients	1996				Patients	1997				Patients
	%LRTI	*n*	%BSI	*n*	>72 hrs (n)	%LRTI	*n*	%BSI	*n*	>72 hrs (n)	%LRTI		%BSI		>72 hrs (n)	%LRTI	*n*	%BSI	*n*	>72 hrs (n)
Jan	10%	*1*	10%	*1*	10	50%	*3*	0%	*0*	6	8%	*1*	0%	*0*	12	0%	*0*	0%	*0*	13
Feb	0%	*0*	0%	*0*	9	22%	*2*	0%	*0*	9	13%	*1*	0%	*0*	8	7%	*1*	0%	*0*	15
Mar	20%	*2*	10%	*1*	10	25%	*1*	25%	*1*	4	15%	*2*	31%	*4*	13	27%	*3*	9%	*1*	11
Apr	13%	*1*	0%	*0*	8	33%	*3*	0%	*0*	9	25%	*2*	25%	*2*	8	54%	*7*	8%	*1*	13
May	33%	*2*	17%	*1*	6	20%	*1*	0%	*0*	5	0%	*0*	6%	*1*	16	15%	*2*	15%	*2*	13
Jun	29%	*2*	14%	*1*	7	33%	*2*	0%	*0*	6	22%	*2*	11%	*1*	9	55%	*6*	0%	*0*	11
Jul	25%	*2*	25%	*2*	8	0%	*0*	20%	*2*	10	43%	*3*	0%	*0*	7					
Aug	25%	*2*	0%	*0*	8	0%	*0*	0%	*0*	2	13%	*1*	0%	*0*	8					
Sep	40%	*2*	20%	*1*	5	25%	*1*	0%	*0*	4	38%	*3*	13%	*1*	8					
Oct	29%	*2*	0%	*0*	7	10%	*1*	0%	*0*	10	0%	*0*	0%	*0*	6					
Nov	22%	*2*	11%	*1*	9	38%	*5*	15%	*2*	13	11%	*1*	0%	*0*	9					
Dec	13%	*1*	0%	*0*	8	17%	*2*	0%	*0*	12	6%	*1*	17%	*3*	18					
>72 hrs	20.0%	*19*	8.4%	*8*	95	23.3%	*21*	5.6%	*5*	90	13.9%	*17*	9.8%	*12*	122	25.0%	*19*	5.3%	*4*	76

Appendix II Table 2
PICU SUMMARY OUTCOME DATA 94-97

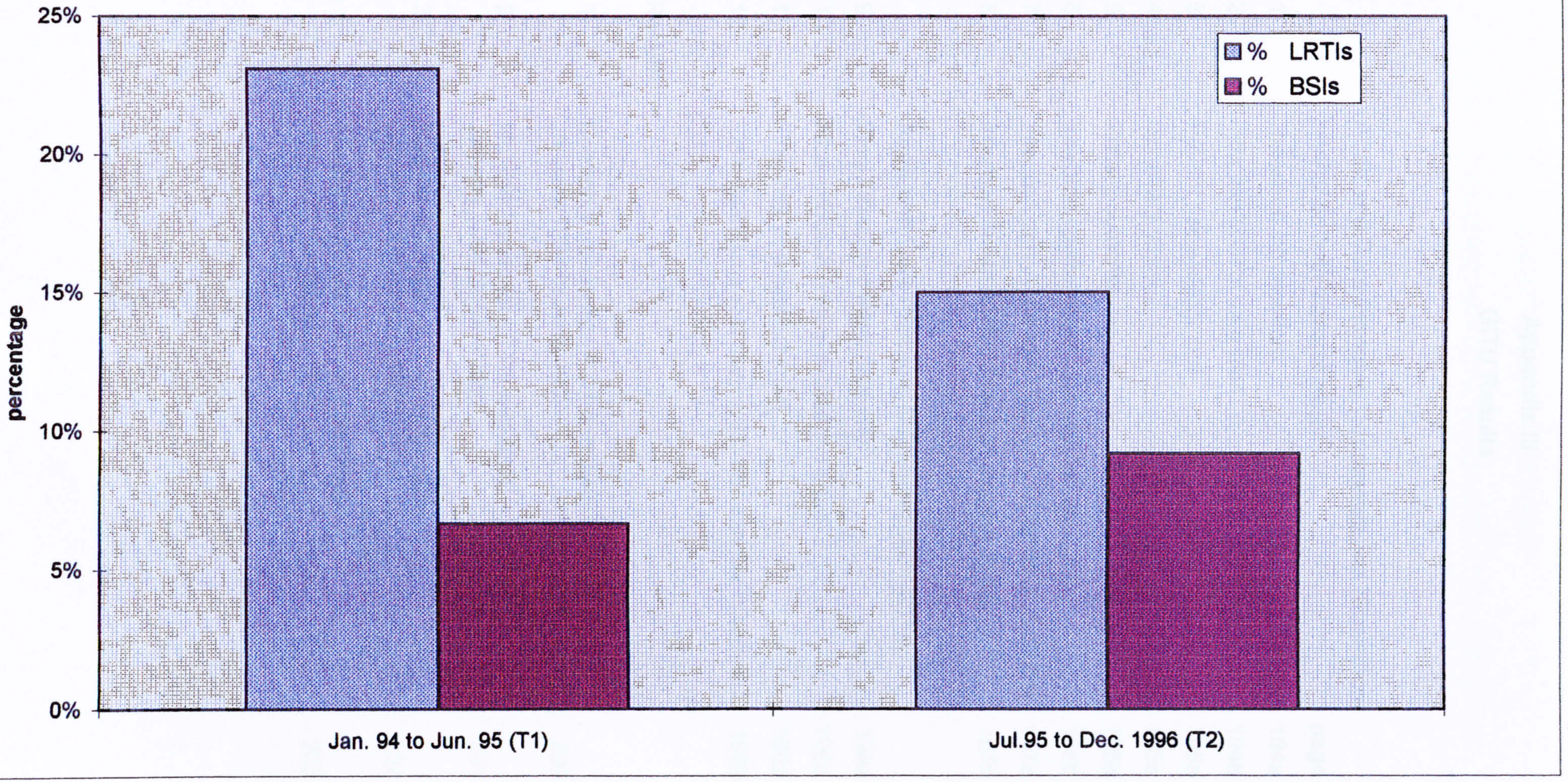
	Pre-audit data			Post audit data		
	1994a	1994b	1995a	1995b	1996a	1996b
Total no admissions (data needs confirming)	220	*all 1994*	111	171	306	*all 1996*
Total no pathology specimens	463	681	599	625	842	592
Respiratory	97	163	153	159	152	145
Blood	112	170	194	195	254	114
IV tip	50	60	51	43	87	57
Children staying>72 hrs						
Total no patients=>72 hr. stay	50	45	39	51	66	56
	43%	*all 1994*	35%	30%	40%	*all 1996*
No patients included in the audit	na	na	na	41	47	50
% patients included in the audit	na	na	na	80.4%	71.2%	89.3%
Missing records	3	2	4	0	0	0
Retrospective audit	*all records audited by retrospective data collection*			10	19	6
Av. age(days) children staying>72 hrs	609.9	935.9	1605.4	751.2	1341.8	1416.9
Av. LOS(days) children staying >72 hrs	15.1	10.3	9.0	9.1	11.6	8.6
Children staying>72 hrs & acquiring LRTI +/-BSI						
No patients acquiring LRTIs and /or BSIs	8	13	12	11	12	12
Percentage of children with LRTI and/or BSI	**16.0%**	**28.9%**	**30.8%**	**21.6%**	**18.2%**	**21.4%**
Average age (days) infected cases	644.3	1278.2	1016.9	378.8	1520.9	1866.4
Average LOS(days) infected cases	12.3	12.8	14.9	14.3	34.6	15.6
Average LOS LRTI only	**pre-audit**	**13.7**		**post-audit**	**24.8**	
Average LOS BSI only	**pre-audit**	**15.9**		**post-audit**	**9.9**	
Average LOS LRTI and BSI	**pre-audit**	**11.8**		**post-audit**	**20.7**	
Total number of LRTIs and BSIs	12	15	13	13	16	13
Combined percentage of LRTIs and BSIs	**24.0%**	**33.3%**	**33.3%**	**25.5%**	**24.2%**	**23.2%**
No ICU-acquired LRTIs	8	11	12	9	8	9
% ICU -acquired LRTIs	**16.0%**	**24.4%**	**30.8%**	**17.6%**	**12.1%**	**16.1%**
No ICU-acquired BSIs	4	4	1	4	8	4
% ICU -acquired BSIs	**8.0%**	**8.9%**	**2.6%**	**7.8%**	**12.1%**	**7.1%**
Summary all admissions	1994(220)	*all 1994*	1995a(111)	1995b(171)	1996(306)	*all 1996*
No children with LRTI and or BSI	*9.5 %(21)*		*8.2% (23)*		*7.8% (24)*	
Percentage of LRTIs for all admissions	*8.6% (19)*		*10.8%(12)*	*5.3%(9)*	*5.6% (17)*	
Percentage od BSIs for all admissions	*3.63%(8)*		*0.9%(1)*	*3.6%(4)*	*3.9%(12)*	

Appendix II Graph 1
Summary PICU-acquired LRTIS and BSIs for children staying>72 hrs
January 1994 - June 1997 (n-383)



Appendix II Graph 2

PICU-acquired LRTIs and BSIs - comparison of rates in T_1 and T_2



Appendix III

GITU Results

UNIVERSITY OF SHEFFIELD

SHEFFIELD CENTRE FOR HEALTH AND RELATED RESEARCH

ACTION RESEARCH PROGRAMME

Developing and Evaluating an

Infection Control Care Planning and Audit System

GENERAL INTENSIVE CARE UNIT

Instructions This file contains documentation for infection control risk assessment, care planning, daily evaluation and recording of patient outcome for one of four site-specific infections; ventilator-associated pneumonia, intravascular device-related blood infections, catheter-related urinary tract infections and surgical wound infections. Clinical signs and symptoms of infection are recorded in stages and outcome indicators for each infection are recorded in four categories. This booklet contains guidelines to assist nursing staff in recording pre-coded data.

Complete all sections of this file for all patients admitted to the GITU. When your patient is discharged place the completed file in the box file A and take a new file from box file B for the next patient.

Do not send this research file with the patient's notes.

Page 1 **The GITU Infection Control Care Plan**

- follow the care plan or adapt it for each patient

Page 2 **Patient risk assessment**

- complete initial risk assessment during first 24 hours
- update risk assessment daily

Page 3 **Routine test requests, results and positive results**

- record daily or as bacteriology requests are ordered or results received
- record if infection is suspected

Page 4 **Daily evaluation of patient's infection status**

- record data daily or as your patient's infection status changes by circling the appropriate codes for each of the four possible categories of outcome indicators for each site-specific infection as follows;

a. clinical signs and symptoms of infection
b. positive bacteriology results
c. new or changed antibiotic prescription
d. written medical diagnosis of infection

A site-specific infection is regarded as positive if

- there is a written medical diagnosis (d) or
- 2 or more positive outcome indicators (a, b or c)

INFECTION CONTROL CARE PLAN

Patient's Problem: Potential risk of acquiring an infection

Goal of care: A. Prevention of new infection B. Early detection of developing infection C. Control of potential cross infection

1. Assess the patient's risks of acquiring an infection *(record on p.2)*. Identify your patient's individual care needs and comply with (or adapt) the following infection control care plan to meet your patient's needs. **Use Universal Precautions for all patients at all times.**

3. **Following hospital and unit infection control policies,** actively prevent acquired infection by using correct techniques and intervals for handwashing, alcohol rub, glove and apron wearing. Use an aseptic technique for the insertion and care of all medical invasive devices and surgical wounds. **Plan your infection control care before action; assess the risks to patients, staff, and visitors to the GITU.**

4. Safely collect, label and transport any bacteriology specimens as requested. Fill in the request form correctly, including all relevant information. Follow hospital policy for labelling and transporting hazardous (potentially infectious) samples. **Record all swabs taken or results received and any new or changed antibiotic prescriptions** *(record daily on p.3 of this file).*

5. Monitor the patient's vital signs - temperature, (record daily on p.3 of this file) pulse & blood pressure for early detection of infection.

6. Monitor all invasive medical devices (endotracheal tubes, intravenous cannulae, urinary catheters), surgical wounds, body fluid drainage and faeces. Record insertion and changes of medical invasive devices *(record on p.2 of this file).*

7. Change IV administration sets every 72 hours, IV infusion bags and IV preparations every 24 hours and all indwelling intravascular cannulae every six days or as clinically indicated. Use a clean technique and disposable non-sterile gloves for respiratory therapy. **Clean and store nebulisers dry between use.**

8. Evaluate the patients infection status, **at least daily**. Assess the presence of possible, probable or actual infection using the guidelines provided *(on pages 6 and 7 at the back of this file).* Modify the care plan in response to changes in the patient's infection status. Document all changes indicative of possible, probable or actual infection *(record daily on p. 4 in this file).*

9. Report to, or seek advice from, the Infection Control Nurse or Doctor regarding a patient's risk of acquiring or transmitting infection if you are unsure about the appropriate precautions that should be taken.

10. Comply with guidelines for Universal Precautions, Hospital Infection Control and Disinfection policies, Health and Safety At Work and COSHH regulations. **If you are unsure about these guidelines, contact the appropriate representative for your area.**

11. Provide your patient and/or the patient's relatives/friends with education and information appropriate to their needs and severity of illness.

RISK ASSESSMENT : DAY 1 to 7

Name	**Unit No:**		**Date of admission:**		...../ ...../			
Diagnosis:			**Type of admission:**		Elective [ ] Emergency [ ]			
			Date discharged/transferred:		...../ ...../ ..... Length of stay [ ]			
Risk Factors for infection	Sex : M [ ] F [ ]		Diabetes (insulin dependent): [ ]		Previous Steroid therapy : [ ]			
	Age >65 [ ] or Age <1 [ ]		Diabetes (NIDDM) : [ ]		Asthmatic : [ ]			
Previous hospital stay (days) [ ] *(Relating to current admission)*			Previous infection/s [ ]		C. Obstructive Airways Disease [ ]			
Previous GITU stay (days) [ ] *(Not including HDU stay)*			Previous antibiotics [ ]		Waterlow Score on admission: [ ]			
	Tick devices & therapies in use	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 7**
RESPIRATORY THERAPY	Nebulised medication [ ]							
Record devices and therapies in use by ticking the boxes	Nebulised saline [ ]							
	ET intubation [ ]							
	Standard tracheostomy [ ]							
	PC tracheostomy [ ]							
INTRAVASCULAR DEVICES	Peripheral line (1) [ ]							
Record devices and therapies	Peripheral line (2) [ ]							
	Peripheral line (3) [ ]							
Change IV devices every 6 days: record as follows	Arterial lines (1) [ ]							
	Arterial lines (2) [ ]							
Inserted record [I]	Central lines (1) [ ]							
Changed record [C]	Central lines (2) [ ]							
Removed record [R]								
	Swann-Ganz (1) [ ]							
OTHERS	Urinary catheter [ ]							
	Surgical wound [ ]							
SURGICAL WOUNDS	Date of first operation : ...../ ..../....	Peri-operative antibiotics: Y N		Given for >48 hrs post-op: Y N				
Record surgical procedure :	Pre-op stay > 7 days Y N	Peri-operative antibiotics used:						
	Major abdominal: [ ]	Burns : [ ]		Major orthopaedic surgery: [ ]				
	Major thoracic : [ ]	Major plastic surgery: [ ]		Operation > 2 hours : [ ]				
Wound Classification	Clean [ ]	Contaminated [ ]		Surgical prosthesis : [ ]				
See reference table II on p.7	Clean/contaminated [ ]	Dirty [ ]		No of wound drains: 1 2 3 >3				

RECORDING INVESTIGATIONS AND RESULTS

Date	Day	WCC	Temp >38	Temp <35	Bacteriology samples and results	Organism cultured	Infection Suspected
		Previous 24 hrs	**Previous 24 hrs**	**Previous 24hrs**			
	1		Y N	Y N	Sputum [ ] results received:. . ./ . . ./ . . . positive culture Y N IV tip [ ] results received:. . ./ . . ./ . . . positive culture Y N Blood [ ] results received:. . ./ . . ./ . . . positive culture Y N CSU [ ] results received:. . ./ . . ./ . . . positive culture Y N SW [ ] results received:. . ./ . . ./ . . . positive culture Y N Other results received:. . ./ . . ./ . . . positive culture Y N	. . . . .	Pneumonia Y N Bacteraemia Y N Septicaemia Y N UTI Y N SWI Y N Non-specific Y N
	2		Y N	Y N	Sputum [ ] results received:. . ./ . . ./ . . . positive culture Y N IV tip [ ] results received:. . ./ . . ./ . . . positive culture Y N Blood [ ] results received:. . ./ . . ./ . . . positive culture Y N CSU [ ] results received:. . ./ . . ./ . . . positive culture Y N SW [ ] results received:. . ./ . . ./ . . . positive culture Y N Other results received:. . ./ . . ./ . . . positive culture Y N	. . . . .	Pneumonia Y N Bacteraemia Y N Septicaemia Y N UTI Y N SWI Y N Non-specific Y N
	3		Y N	Y N	Sputum [ ] results received:. . ./ . . ./ . . . positive culture Y N IV tip [ ] results received:. . ./ . . ./ . . . positive culture Y N Blood [ ] results received:. . ./ . . ./ . . . positive culture Y N CSU [ ] results received:. . ./ . . ./ . . . positive culture Y N SW [ ] results received:. . ./ . . ./ . . . positive culture Y N Other results received:. . ./ . . ./ . . . positive culture Y N	. . . . .	Pneumonia Y N Bacteraemia Y N Septicaemia Y N UTI Y N SWI Y N Non-specific Y N
	4		Y N	Y N	Sputum [ ] results received:. . ./ . . ./ . . . positive culture Y N IV tip [ ] results received:. . ./ . . ./ . . . positive culture Y N Blood [ ] results received:. . ./ . . ./ . . . positive culture Y N CSU [ ] results received:. . ./ . . ./ . . . positive culture Y N SW [ ] results received:. . ./ . . ./ . . . positive culture Y N Other results received:. . ./ . . ./ . . . positive culture Y N	. . . . .	Pneumonia Y N Bacteraemia Y N Septicaemia Y N UTI Y N SWI Y N Non-specific Y N
	5		Y N	Y N	Sputum [ ] results received:. . ./ . . ./ . . . positive culture Y N IV tip [ ] results received:. . ./ . . ./ . . . positive culture Y N Blood [ ] results received:. . ./ . . ./ . . . positive culture Y N CSU [ ] results received:. . ./ . . ./ . . . positive culture Y N SW [ ] results received:. . ./ . . ./ . . . positive culture Y N Other results received:. . ./ . . ./ . . . positive culture Y N	. . . . .	Pneumonia Y N Bacteraemia Y N Septicaemia Y N UTI Y N SWI Y N Non-specific Y N

DAILY EVALUATION OF INFECTION STATUS

Date	Day	Outcome Indicators	Pneumonia *[SP] = sputum/bronchial asp*	Blood infection *[BL] = blood culture*	Urinary Infection *[CSU] = specimen of urine*	Wound Infection *[SW] = wound swab/specimen*
	1	**a. Infection status** b. Positive bacteriology **c. New/changed antibiotic** d. Written medical diagnosis	**a. 0 1 2 3** b. [SP] N Y **c.** N Y d. N Y	**a. 0 1 2 3 4** b. [BL] N Y **c.** N Y d. N Y	**a. 0 1 2 3 4** b. [CSU] N Y **c.** N Y d. N Y	**a. 0 1 2 3 4** b. [SW] N Y **c.** N Y d. N Y
	2	**a. Infection status** b. Positive bacteriology **c. New/changed antibiotic** d. Written medical diagnosis	**a. 0 1 2 3** b. [SP] N Y **c.** N Y d. N Y	**a. 0 1 2 3 4** b. [BL] N Y **c.** N Y d. N Y	**a. 0 1 2 3 4** b. [CSU] N Y **c.** N Y d. N Y	**a. 0 1 2 3 4** b. [SW] N Y **c.** N Y d. N Y
	3	**a. Infection status** b. Positive bacteriology **c. New/changed antibiotic** d. Written medical diagnosis	**a. 0 1 2 3** b. [SP] N Y **c.** N Y d. N Y	**a. 0 1 2 3 4** b. [BL] N Y **c.** N Y d. N Y	**a. 0 1 2 3 4** b. [CSU] N Y **c.** N Y d. N Y	**a. 0 1 2 3 4** b. [SW] N Y **c.** N Y d. N Y
	4	**a. Infection status** b. Positive bacteriology c. New/changed antibiotic d. Written medical diagnosis	**a. 0 1 2 3** b. [SP] N Y **c.** N Y d. N Y	**a. 0 1 2 3 4** b. [BL] N Y **c.** N Y d. N Y	**a. 0 1 2 3 4** b. [CSU] N Y **c.** N Y d. N Y	**a. 0 1 2 3 4** b. [SW] N Y **c.** N Y d. N Y
	5	**a. Infection status** b. Positive bacteriology **c. New/changed antibiotic** d. Written medical diagnosis	**a. 0 1 2 3** b. [SP] N Y **c.** N Y d. N Y	**a. 0 1 2 3 4** b. [BL] N Y **c.** N Y d. N Y	**a. 0 1 2 3 4** b. [CSU] N Y **c.** N Y d. N Y	**a. 0 1 2 3 4** b. [SW] N Y **c.** N Y d. N Y

COMMUNICATION AND SPECIAL INFECTION CONTROL PRECAUTIONS

MRSA : [ ]	Date . . . / . . . / . . . Site:	Barrier nursing: [ ]	Date: . . . / . . . / . . .
Multi-resistant organism: [ ]	Date . . . / . . . / . . . Site:	Reverse barrier nursing: [ ]	Date: . . . / . . . / . . .

Additional information — IC Team Informed : [ ] Date: . . / . . / .

Date	Time	Comments	Signature

REFERENCE TABLE I : Guidelines for recording device-related infection status				
Stage	**General Description**	**Ventilator-associated pneumonia**	**IV device-related blood infection**	**Urinary catheter-related infection**
0	**No signs of infection** Patient "at-risk"	• ET tube in place • no signs of infection	• IV device in place • no signs of infection	• urinary catheter in place • no signs of infection
1	**Possible Infection**	• increase in volume of sputum	• restricted blood flow or • blocked IV or • haematoma	• offensive smelling urine
2	**Probable Infection** This can include an unconfirmed diagnosis of infection	• increasing volumes of sputum **and** • purulent chest secretions (yellow/green/brown)	• erythema at the IV site or • red, palpable vein chord or • pus at the IV insertion site or positive bacteriology report of swab from skin around the IV site	• cloudy or • offensive smelling urine
3	**Actual infection**	**PNEUMONIA** • presence of purulent chest secretions **and** • presence of new radiological changes, consolidation, new or progressive infiltrate, not explained by a previously diagnosed disease **and/or** • evidence of respiratory compromise-deterioration of blood gases or difficulty in adequate lung ventilation.	**BACTERAEMIA** In the absence of sample contamination **without signs of systemic infection,** • positive IV catheter tip culture (see bacteriology report) **and a positive blood culture** from one or more blood cultures obtained on the same occasion **and/or** • positive blood culture from two or more blood cultures obtained on separate occasions	**BACTERIURIA** In the absence of sample contamination **without signs of systemic infection,** • presence of micro-organisms in a CSU (>100, 000 cfu per ml) with no more than 2 species of micro-organism **and** • repeated isolation of the same micro-organism from a subsequent CSU with no more than two species of micro-organism
4	**Actual infection**	**Not applicable**	**SEPTICAEMIA** As stage 3 and in the absence of sample contamination and **with evidence of systemic blood infection, e.g.** • Pyrexia (>38 degrees) or • Hypothermia (<35 degrees) • Rigors, Tachycardia, Hypotension	**URINARY TRACT INFECTION** As stage 3 and in the absence of sample contamination and **with evidence of systemic infection, e.g.** • Pyrexia (>38 degrees) or • Hypothermia (<35 degrees) • Rigors,Tachycardia, Hypotension

Guidelines adapted and developed from expertly derived definitions for infection - Glenister et 1992, Spencer et al 1993 and Waghorn 1994

TABLE II : CLASSIFICATION OF SURGICAL WOUNDS Page 7		
Classification	**Coding**	**Examples**
Clean	**CL**	Elective, primarily closed and undrained Non-traumatic, uninfected No inflammation encountered No break in aseptic technique Respiratory, alimentary, genito-urinary or oropharyngeal tracts **not entered**
Clean-contaminated	**CC**	Alimentary, respiratory or genito-urinary tracts entered under controlled conditions without any unusual contamination eg - Appendicectomy - Oropharynx entered - Vagina entered - Genitourinary tract entered in absence of positive urine culture - Bilary Tract entered in absence of infected bile - Gastro-intestinal tract entered without evidence of inflammation or infection - Minor break in surgical technique - Mechanical drainage
Contaminated	**CT**	Open fresh traumatic wounds Gross spillage from gastrointestinal tract Entrance of genitourinary or bilary tracts in presence of infected urine or bile Major break in surgical technique Incisions in which acute non-purulent inflammation is present eg Gastro-intestinal tract entered with evidence of inflammation/infection
Dirty and Infected	**D**	Traumatic wound with retained devitalised tissue, foreign bodies, faecal contamination, or delayed treatment, or from a dirty source

Wound Classification taken from: Mayhall 1993 Surgical Infections Including Burns in Prevention and Control of Nosocomial Infections Edited by Wenzel pp.615 Williams and Wilkins USA

The ASEPSIS wound score as taken from: "The use of a wound scoring method 'ASEPSIS' in postoperative wound surveillance." A.P.R. Wilson et al .1990 Journal of Hospital infection 16, pp297-309 and Lancet Feb 8 1986 pp.311-312 and Lancet Feb 24 1986 pp. 1208-1209

REFERENCE TABLE III : The ASEPSIS Wound Scoring System
Instructions - to evaluate surgical wound infection status, add the scores from table IIIa to those from table IIIb. Interpret the score in Table IIIc and record the daily surgical wound infection status (0, 1, 2, 3 or 4) on page 4

Table IIIa PRIMARY ASSESSMENT OF WOUND INFECTION

Wound Characteristic	Proportion of Wound Affected (%)				
	< 20	20 - 39	40 - 59	60 - 79	> 80
Serous exudate	1	2	3	4	5
Erythema .	1	2	3	4	5
Purulent exudate	1	4	6	8	10
Separation of deep tissue	2	4	6	8	10

Table IIIb Additional Points to be added to the ASEPSIS wound score

Additional Treatment as a result of a wound infection	Points
New or changed antibiotics	10
Drainage of pus under local anaesthesia	5
Debridement of wound under general anaesthesia (return to theatre)	10
Serous Discharge	5
Erythema	5
Purulent exudate	10
Separation of deep tissues	10
Isolation of bacteria	10
GITU stay prolonged (>14 days) as a direct result of wound infection	5

PATIENT'S PROBLEM Goal of care	POTENTIAL RISK OF ACQUIRING AN INFECTION • Prevention of new infection • Early detection of developing infection • Co-ordinating appropriate treatment of infection • Control of potential cross infection	Patient name or ID sticker here ↓

1. Care Planning

- Plan your infection control care before action: assess the risks to patients, staff, and visitors to GITU
- Evaluate the patient's infection status : ***on a shift-by-shift basis***
  assess the presence of possible, probable or actual infection & modify this care plan in response to changes in infection status

2. Nursing Action

- Actively prevent acquired infection by using ***correct techniques*** and ***intervals*** for ***handwashing, alcohol rub, glove*** and apron wearing
- Use an ***aseptic technique*** for the ***insertion and care of all medical invasive devices and surgical wounds***
- Monitor temperature and WCC
- Monitor all invasive medical devices (ET tubes, IV cannulae, urinary catheters), surgical wounds, body fluid drainage and faeces
- Change IV administration sets every 72 hours, IV infusion bags and IV preparations every 24 hours
- Change indwelling intravascular cannulae every six days or as clinically indicated
- Use a clean technique and disposable non-sterile gloves for respiratory therapy
- Clean and dry nebulisers between use, dispense nebuliser solutions using an aseptic technique

3. Daily Documentation

- Record insertion and changes of medical invasive devices
- Record all swabs taken or results received and any suspected infections
- Record ***core temperature and WCC*** for early detection of infection
- Document all changes indicative of possible, probable or actual infection

4. Follow hospital and unit infection control policies

- Safely collect, label and transport all bacteriology specimens : fill in the request form correctly, including all relevant information
- Comply with guidelines for Hospital Infection Control and Disinfection : use Universal Precautions for all patients at all times
- Comply with regulations for Health and Safety At Work, COSHH regulations, food hygiene and disposal of waste
- Report to, or seek advice from, the Infection Control Nurse/Doctor if you are unsure about potential risks of infection to or from the patient

5. Education and communication

Provide your patient and/or the patient's relatives/friends with education and information appropriate to their needs and severity of illness. Communicate additional bacteriological and infection control information to other staff on GITU and to staff in other wards and hospitals when patients are transferred

BACTERIOLOGICAL and INFECTION CONTROL INFORMATION

MRSA : [ ] Date . . . / . . . / . . . Primary Site:	MRSA other sites :
Multi-resistant organism : [ ] Date . . . / . . . / . . . Organism cultured : sensitive to : Primary Site:	Multi-resistant organisms other sites :

IC Team Informed: [ ] Date . . / . . . / . . .	Barrier nursing [ ] Date started. . . / . . . / . . . Date stopped . . . / . . . / . .
Special Instructions	Reverse barrier nursing [ ] Date started. . . / . . . / . . .Date stopped . . . / . . . / . .

Date . . . / . . . / . . .	Date discontinued . . . / . . . / . . .
Date . . . / . . . / . . .	Date discontinued . . . / . . . / . . .
Date . . . / . . . / . . .	Date discontinued . . . / . . . / . . .
Date . . . / . . . / . . .	Date discontinued . . . / . . . / . . .
Date . . . / . . . / . . .	Date discontinued . . . / . . . / . . .
Date . . . / . . . / . . .	Date discontinued . . . / . . . / . . .
Date . . . / . . . / . . .	Date discontinued . . . / . . . / . . .
Date . . . / . . . / . . .	Date discontinued . . . / . . . / . . .

COMMUNICATION : Additional Information

Date	Time	Communication	Signature

RISK FACTORS FOR HOSPITAL ACQUIRED INFECTION (HAI)

The majority of patents requiring care on GITU will be totally dependent on clinical staff to meet their needs for hygiene and preventing infection

Considering some of the risk factors for HAI may help to identify your patient's need for preventative nursing action.

Utilising the Waterlow score

Many patient related risk factors for HAI appear within the Waterlow scoring system for assessing the patient's risk of acquiring pressure sores
A high Waterlow score indicates the patient's increased risk of HAI

Patient related factors	**Increased Risks**
• Age:	young or elderly
• Diagnosis:	increased severity of illness
• Underlying disease:	diabetes, malignancy, respiratory impairment
• Use of certain drugs:	immuno-suppressants: steroids, chemotherapy
• Nutritional status:	weight loss
• Weight for height:	obesity
• Antibiotic therapy :	previous/current use
• Infection:	previous/current infection

Treatment related factors	**Increased Risks**
• Type of admission:	emergency/urgent admissions
• Respiratory	intubation/ventilation and respiratory therapy
• Fluid replacement and monitoring	intravascular devices, therapies and care
• Urinary system	catheter placement and care

Surgical risk factors	**Increased Risks**
• Type of operation:	major abdominal or thoracic surgery
• Duration of operation:	longer than two hours
• Pre-op stay:	longer than 7 days
• Drains / Prostheses:	presence of foreign material
• Wound classification:	contaminated or dirty wounds

GITU Definition and stages of site-specific infection
Chart 14

Guidelines for recording device-related infection status				
Stage	**General Description**	**Lower Respiratory Tract Infection**	**IV device-related blood infection**	**Urinary catheter-related infection**
0	• No signs of infection • *Patient "at-risk"*	• ET tube in place • No signs of infection	• IV device in place • No signs of infection	• Urinary catheter in place • No signs of infection
1	• Possible Infection	• Increase in volume of sputum	• Restricted blood flow or • Blocked IV or • Haematoma	• offensive smelling urine
2	• Probable Infection • *This can include an unconfirmed diagnosis of infection*	• Increasing volumes of sputum and • Purulent chest secretions (yellow/green/brown)	• Erythema at the IV site or • Red, palpable vein chord or • Pus at the IV insertion site or • Positive bacteriology report of swab from skin around the IV insertion site	• cloudy or • offensive smelling urine
3	• Actual infection	PNEUMONIA • Presence of purulent chest secretions and • Presence of new radiological changes, consolidation, new or progressive infiltrate, not explained by a previously diagnosed disease and/or • Evidence of respiratory compromise-- deterioration of blood gases or difficulty in adequate lung ventilation.	BACTERAEMIA In the absence of sample contamination without signs of systemic infection: • Positive IV catheter tip culture (see bacteriology report) and a positive blood culture from one or more blood cultures obtained on the same occasion and/or • Positive blood culture from two or more blood cultures obtained on separate occasions	BACTERIURIA In the absence of sample contamination without signs of systemic infection, • presence of micro-organisms in a CSU (>100, 000 cfu per ml) with no more than 2 species of micro-organism and • repeated isolation of the same micro-organism from a subsequent CSU with no more than two species of micro-organism
4	Actual infection	Not applicable	SEPTICAEMIA • As stage 3 with evidence of systemic blood infection and in the absence of sample contamination	URINARY TRACT INFECTION • As stage 3 with evidence of systemic infection and in the absence of sample contamination

Guidelines adapted and developed from expertly derived definitions for infection - Glenister et 1992, Spencer et al 1993 and Waghorn 1994

Appendix III Table 1
GITU summary data

	Summary January 1994 to May 1997
Patients with length of stay>72 hrs in GITU	**382**
Average age (years)	59.0
Males	238
Females	143
Average length of stay (hrs)	12.0
Deaths	100
Patients with length of stay>72 hrs acquiring LRTIs and/or BSIs	**77**
Percentage of all adults staying > 72 hrs with LRTI and/or BSIs	20.2%
Deaths	28
Males	54
Females	22
Average age (years) patients with ITU-acquired infection	61.0
Average length of stay (days) patients with ITU-acquired infection	451.0
Patients with length of stay>72 hrs acquiring LRTIs and/or BSIs	
Number of patients with one or more LRTIs and/or BSIs	77
Number of ITU-acquired LRTIs	67
Number of ITU-acquired BSIs	45
Number of patients with LRTI only	37
Average age of patients with LRTI only	64.0
Average length of stay of pateints with LRTI only	413.8
Number of patients with BSI only	13
Average age of patients with BSI only	62.0
Average length of stay patients with BSI only	437.3
Number of patients with LRTI and BSI	27
Average age of patients with both LRTI and BSI	59.3
Average length of stay of patients with both LRTI and BSI	501.9
Summary all patients admitted to GITU	**1211**
% patients with one or more LRTIs/BSIs	6.4%
Incidence (%) of LRTIs for all admissions	5.5%
Incidence (%) of BSIs for all admissions	3.7%
Combined percentage of LRTIs and BSIs	9.2%

	n	%
Male	26	70%
Female	11	30%
Deaths	13	35%
Male	7	54%
Female	6	46%
Deaths	6	46%
Male	22	81%
Female	5	19%
Deaths	9	33%

Appendix III Table 2
GITU trends of LRTIs and BSIs by month for patients staying >72 hours

			January 1994 - May 1997					
			>72 hrs			all admissions		
	No.LRTI	No.BSI	%LRTI	%BSI	n	%LRTI	%BSI	n
Jan-94	1	0	10.0%	0.0%	10	3.6%	0.0%	28
Feb-94	3	2	75.0%	50.0%	4	11.5%	7.7%	26
Mar-94	3	0	50.0%	0.0%	6	15.0%	0.0%	20
Apr-94	1	1	25.0%	25.0%	4	5.6%	5.6%	18
May-94	0	0	0.0%	0.0%	8	0.0%	0.0%	25
Jun-94	1	2	11.1%	22.2%	9	4.2%	8.3%	24
Jul-94	3	3	37.5%	37.5%	8	13.6%	13.6%	22
Aug-94	0	0	0.0%	0.0%	5	0.0%	0.0%	29
Sep-94	1	2	10.0%	20.0%	10	3.7%	7.4%	27
Oct-94	2	2	40.0%	40.0%	5	10.0%	10.0%	20
Nov-94	1	1	16.7%	16.7%	6	3.4%	3.4%	29
Dec-94	1	0	14.3%	0.0%	7	3.2%	0.0%	31
Jan-95	0	0	0.0%	0.0%	5	0.0%	0.0%	25
Feb-95	0	1	0.0%	7.1%	14	0.0%	2.9%	34
Mar-95	0	0	0.0%	0.0%	5	0.0%	0.0%	22
Apr-95	1	3	12.5%	37.5%	8	3.6%	10.7%	28
May-95	1	0	16.7%	0.0%	6	4.2%	0.0%	24
Jun-95	1	0	16.7%	0.0%	6	4.8%	0.0%	21
Jul-95	2	0	20.0%	0.0%	10	6.5%	0.0%	31
Aug-95	1	2	9.1%	18.2%	11	3.7%	7.4%	27
Sep-95	2	3	16.7%	25.0%	12	8.0%	12.0%	25
Oct-95	1	0	7.7%	0.0%	13	3.8%	0.0%	26
Nov-95	1	1	11.1%	11.1%	9	2.8%	2.8%	36
Dec-95	1	1	12.5%	12.5%	8	4.0%	4.0%	25
Jan-96	2	1	12.5%	6.3%	16	5.6%	2.8%	36
Feb-96	1	1	9.1%	9.1%	11	2.9%	2.9%	34
Mar-96	2	0	25.0%	0.0%	8	6.3%	0.0%	32
Apr-96	3	1	33.3%	11.1%	9	10.7%	3.6%	28
May-96	0	0	0.0%	0.0%	7	0.0%	0.0%	22
Jun-96	3	2	25.0%	16.7%	12	8.1%	5.4%	37
Jul-96	4	3	28.6%	21.4%	14	10.3%	7.7%	39
Aug-96	2	2	14.3%	14.3%	14	6.3%	6.3%	32
Sep-96	4	3	40.0%	30.0%	10	9.8%	7.3%	41
Oct-96	2	0	18.2%	0.0%	11	5.9%	0.0%	34
Nov-96	1	2	7.7%	15.4%	13	3.0%	6.1%	33
Dec-96	2	2	22.2%	22.2%	9	6.7%	6.7%	30
Jan-97	1	0	7.1%	0.0%	14	3.0%	0.0%	33
Feb-97	1	0	14.3%	0.0%	7	2.7%	0.0%	37
Mar-97	1	0	6.3%	0.0%	16	2.7%	0.0%	37
Apr-97	5	1	41.7%	8.3%	12	10.4%	2.1%	48
May-97	5	3	50.0%	30.0%	10	14.3%	8.6%	35
	67	45	18.7%	12.4%	382	5.5%	3.8%	1211

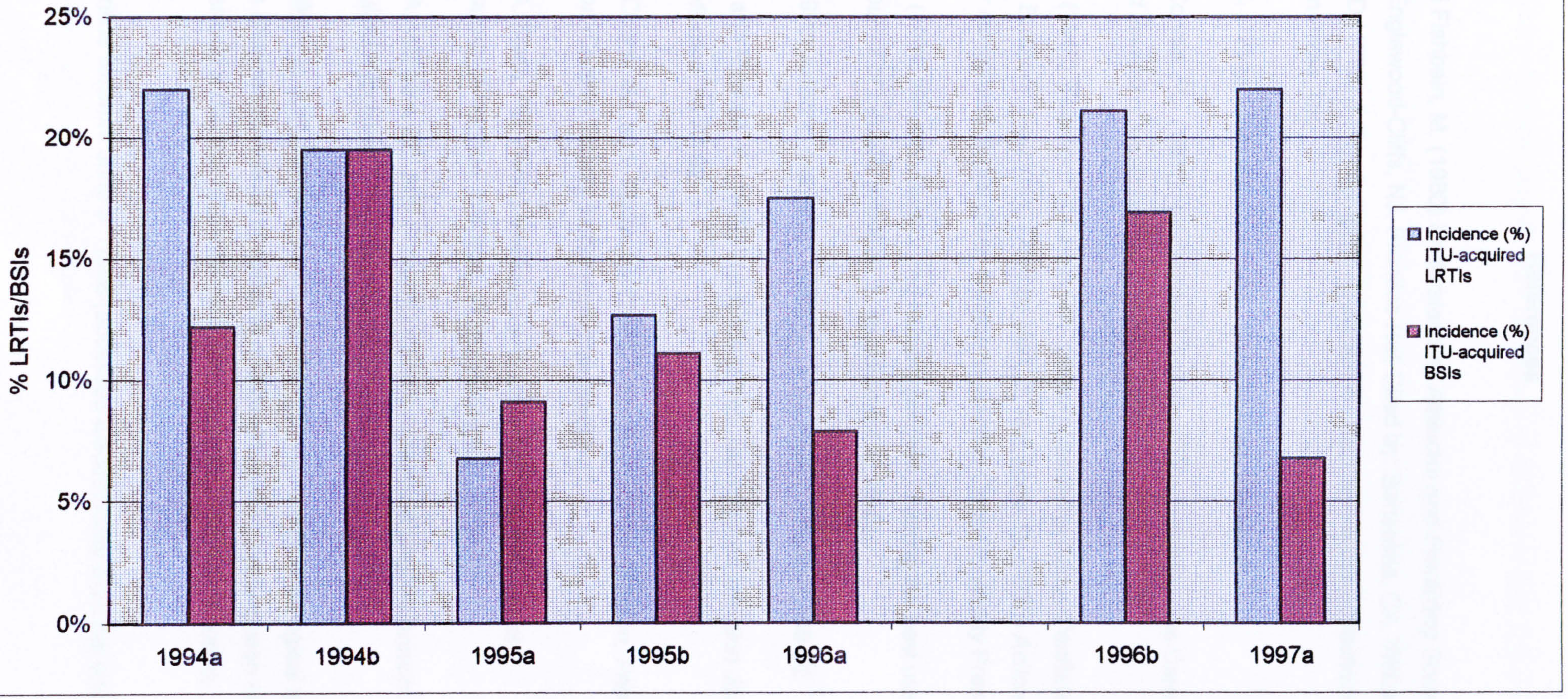
Appendix III Table 3

Patients with length of stay> 72 hrs

	Pre-audit data					Post audit data	
	1994a	1994b	1995a	1995b	1996a	1996b	1997a
Patients with length of stay>72 hrs in GITU	**43**	**43**	**46**	**63**	**66**	**72**	**60**
Average age (years)	55	62	59	58	61	60	60
Males	26	27	25	37	39	50	41
Females	17	16	21	26	27	22	19
Average length of stay (hrs)	401	249	326	277	262	291	280
Deaths	12	13	15	12	26	20	10
Patients with length of stay>72 hrs acquiring LRTIs and/or BSIs**	7	11	5	12	13	17	12
Percentage of all adults staying > 72 hrs with LRTI and/or BSIs	16.28%	25.58%	10.87%	19.05%	19.70%	23.61%	20.00%
Deaths	1	4	2	5	6	7	3
Males	**4***	8	2	6	10	15	9
Females	**2***	3	3	6	3	2	3
Number of ITU-acquired LRTIs	9	8	3	8	11	15	13
Incidence (%) ITU-acquired LRTIs	20.9%	18.6%	6.5%	12.7%	16.7%	20.8%	21.7%
Number. of ITU-acquired BSIs	5	8	4	7	5	12	4
Incidence (%) ITU-acquired BSIs	11.6%	18.6%	8.7%	11.1%	7.6%	16.7%	6.7%
Total number of LRTIs and BSIs	14	16	7	15	16	23	17
Combined percentage of LRTIs and BSIs	32.6%	37.2%	15.2%	23.8%	24.2%	31.9%	28.3%
Summary patients with length of stay>72 hrs with positive bacteriology	**23**	**26**	**27**	**44**	**36**	**51**	**39**
Total number of LRTIs	9	8	3	8	11	15	13
Incidence (%) of LRTIs for patients staying>72 hrs & positive bacteriology	39.1%	30.8%	11.1%	18.2%	30.6%	29.4%	33.3%
Total number of BSIs	5	8	4	7	5	12	4
Incidence (%) of BSIs for patients staying>72 hrs & positive bacteriology	21.8%	30.8%	14.8%	15.9%	13.9%	23.5%	10.3%
Summary all patients admitted to GITU	**141**	**158**	**154**	**170**	**189**	**209**	**190**
Incidence (%) of LRTIs for all admissions	6.4%	5.1%	1.9%	4.7%	5.8%	7.2%	6.8%
Incidence (%) of BSIs for all admissions	3.5%	5.1%	2.6%	4.1%	2.6%	5.7%	2.1%

Appendix III, Graph 1

GITU incidence (%) of LRTIs and BSIs for all admissions staying>72hr (n=382)
January 1994 to June 1997



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