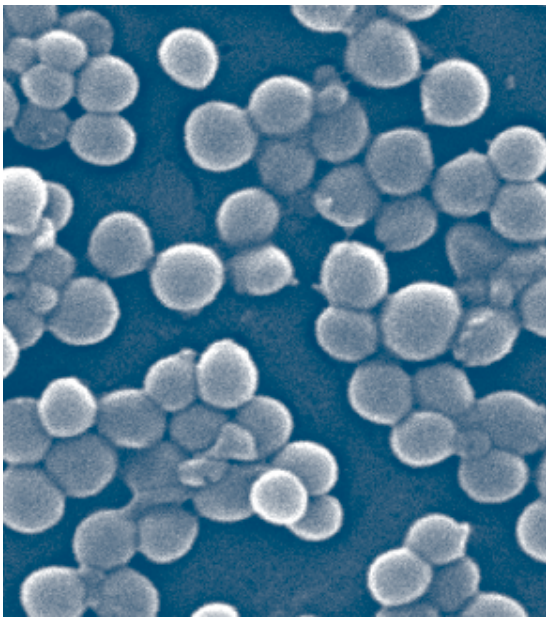
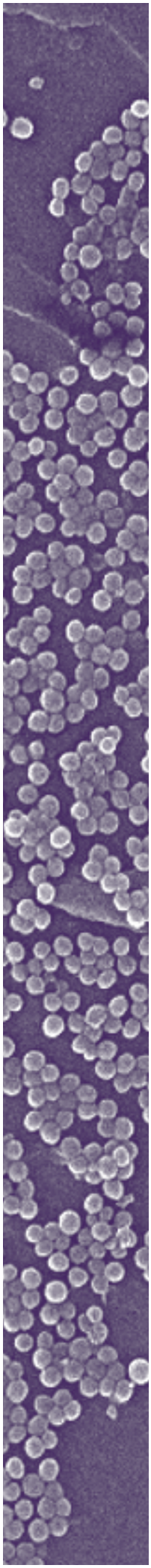
Health Protection Agency

Surveillance of Healthcare Associated Infections Report: 2008





Acknowledgements

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July 2008

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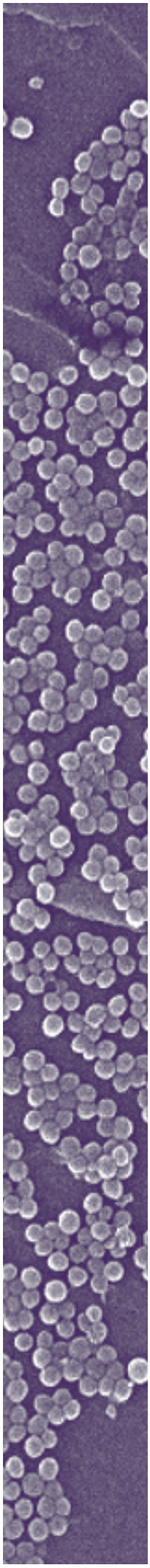


Contents

Glossary of terminology & abbreviations:

Voluntary surveillance – laboratories in many hospitals in England, Wales &, more recently, Northern Ireland have been sending reports of pathogens isolated from clinically significant infections to the HPA and, before that, to the Public Health Laboratory Service, over very many years. This started off under the Emergency Public Health Laboratory Service after the Second World War.

Mandatory surveillance – a programme of mandatory surveillance of certain HCAI was established by the Department of Health in England in 2001. The first component was surveillance of *S. aureus* bloodstream infections, which started in April 2001. This has been followed by surveillance of GRE bloodstream infections (2003), *C. difficile* infection (2004), orthopaedic surgical site infection (2004) and monitoring of adverse incidents associated with HCAI (outstanding).

A&E – Accident & Emergency Department

Augmented care – care provided in an intensive care unit or high dependency unit.

Bacteraemia – a bloodstream infection caused by bacteria

BSI – bloodstream infection

CABG – coronary artery bypass graft

CDI – *C. difficile* infection

CNS - Coagulase Negative Staphylococci

CSCI – Commission for Social Care Inspection

EARSS – European Antimicrobial Resistance Surveillance System

ECDC – European Centre for Disease Prevention and Control

GRE - glycopeptide resistant enterococci

HAI – Hospital Acquired Infection

HCAI - Healthcare Associated Infection

HELICS – Hospital in Europe Link for Infection Control through Surveillance – a European network for surveillance of healthcare-associated infections

MRI – Magnetic Resonance Imaging

MRSA – meticillin-resistant *Staphylococcus aureus*

MSSA - meticillin-susceptible *Staphylococcus aureus*

ORLBF – open reduction of long bone fracture

PDS - Post-discharge surveillence

PVL-SA – *Staphylococcus aureus* producing Panton-Valentine Leukocidin

SSI – Surgical Site Infection

SSISS - Surgical Site Infection Surveillance System

WHO – World Health Organisation

Introduction

This is the third report on the surveillance of healthcare-associated infections (HCAI) in England. This year, the report is being published in tandem with the report on the surveillance of antimicrobial resistance and prescribing, as the two are complementary. The report has also been expanded to include broader contributions on activities in the surveillance, prevention and control of HCAI from across the HPA. It is a 'work in progress'. It aims to cover the calendar year 2007 or financial year 2007/8, whichever is more appropriate for the infection surveillance system under review.

The aim of this report is to identify key information on HCAI in England, demonstrating the burden of infection when possible, trends, notable events, impact of activities and gaps that need attention. Discussion of data on infection cannot be separated from discussion of the sources of the data and the 'health warnings' on interpretation of the data. These are very important as it is not always possible to compare 'like with like'. They are illustrated briefly in the individual sections, but in more detail at Appendix 2. At this point it is also important to remind readers that not all HCAI are preventable. Some arise from micro-organisms carried by the patient, whilst others gain a foothold in patients who are compromised by their treatment or their illness (Appendix 1). Many of these infections cannot be prevented, but this should not lead to complacency around tackling the infections that are preventable and engaging in the battle to continually drive down rates of HCAI. In addition, this report deals generally with trends in bloodstream infections to give the context for those caused by HCAI. However, not all bloodstream infections are healthcare-associated. Many are due to infections acquired in the community.

What has changed in the period since the last report?

The high political profile of this area of work continues and developments in the surveillance of HCAI continue apace. Repercussions from the Healthcare Commission investigation into *C. difficile* infections and mortality at Maidstone and Tunbridge Wells NHS Trust are still being felt, with a considerable increase in the profile of *C. difficile* infections, which now overshadows that of MRSA bacteraemia. There has been significant evolution of the surveillance system for *C. difficile* infections, making it more robust in a similar way to earlier developments to the MRSA bacteraemia system, and refining it in preparation for monitoring of the new national target. The latter will require monitoring of infections by Primary Care Organisation, a significant departure for national surveillance of HCAI. Another significant initiative was the re-development of the web-enabled system for MRSA bacteraemia and *C. difficile* infection surveillance to allow access by healthcare providers in the Independent Sector at the beginning of 2008.

What do the data show?

Last year we stated that we were confident that the downward trend in MRSA bacteraemia heralded a real change, something most specialists in the field would have thought impossible only a few years ago, after the inexorable rise in MRSA bloodstream infections throughout the 1990s. Fortunately this confidence was not misplaced, the fall in MRSA bacteraemia continuing in the period since, indicating that the national target is achievable. However, the question that then arises is whether this is sustainable in the absence of a national target and rigorous performance management.

The developments in the surveillance and monitoring of *C.difficile* infection lag behind those for MRSA bacteraemia, the mandatory surveillance being established nearly three years later and significant changes to improve the surveillance occurring in the past year. Early indications are that the numbers of these infections are starting to fall, but, in the light of all the recent changes, more time is required to assess whether this heralds the same type of downturn that we have seen for the MRSA bloodstream infections.

Rates for other infections under mandatory national surveillance, such as surgical site infection and bloodstream infections due to glycopeptide-resistant enterococci (GRE) are low by comparison. Rates of infection in the orthopaedic surgery categories have significantly reduced since the surveillance became mandatory in 2004 . However, although the numbers of GRE bacteraemias are relatively low, there have been localised outbreaks and the numbers associated with London Trusts are increasing, indicating the need for some targeted attention to this infection.

Mention was made earlier of gastrointestinal infections caused by *C. difficile*. Currently, in England, most of these infections are healthcare-associated. This situation is changing in some other countries, where an increasing proportion of infections appear to be unrelated to the traditional risk factors for *C. difficile* associated infection. The situation in this country needs to be kept under close scrutiny to provide early warning of similar changes here. Although *C. difficile* accounts for a significant proportion of gastrointestinal infections, noroviruses are the most commonly detected pathogen in

both sporadic cases and outbreaks of gastroenteritis. They have a major impact in the community as well as in hospitals. Unlike *C. difficile*, norovirus infection is usually short-lived and not serious, although uncomfortable. However, infection is eminently transmissible and outbreaks in hospitals can cause severe, and costly, disruption to services. This year's season started uncharacteristically early in October 2007 and peaked in the second week of 2008, with the highest number of norovirus reports ever received in a single week.

The most common cause of bloodstream infections is *E. coli*, which accounts for 18% of all reported bloodstream infections. This proportion has remained stable over the past 5 years. Whilst numbers of bloodstream infections due to *S. aureus* continue to fall, those due to coagulase-negative staphylococci are rising. It is difficult to assess from the current data whether this reflects increased reporting of bacteraemias which were not clinically significant or true infections due to these organisms in vulnerable groups of patients. During the period 2003 to 2007 numbers of reported bloodstream infections associated with *Candida* species have risen by 37% whilst those associated with *Streptococcus pneumoniae* have reduced by 13%.

At the opposite end of the spectrum, *Listeria monocytoges* is an uncommon cause of bloodstream infections, but this clinical presentation of listeriosis has become increasingly common (without central nervous system involvement), particularly in those over 60 years of age.

How do the English data compare with other countries?

International comparison of infection rates is fraught with difficulties as the rules governing the collection of the surveillance information vary between countries. Differences in how surveillance is undertaken, definitions, progress in developing surveillance, ascertainment, reporting compliance, approaches to infection control and the socio-economic status of individual countries all impact on the data. Even when attempts are made to harmonise collection methods, surveillance criteria and definitions in surveillance networks, such as the 'Improving Patient Safety in Europe'(IPSE) project[1], there is still some variation between participants, for instance whether post-discharge surveillance is included in surgical site infection surveillance. Commonly comparison is made between the findings from prevalence surveys undertaken in acute hospitals in industrialised countries. These surveys are 'snapshots' at a particular time. They tend to agree about the most common HCAI (urinary tract infections, respiratory tract infections, surgical site infections and bloodstream infections) and the most common causative pathogens (*S. aureus* and *E. coli*), though the role of gastrointestinal infections, particularly those due to *C. difficile* can vary significantly between countries. In these surveys the percentage of patients with a hospital-acquired infection ranges from about 5 to 11%, averaging at around 7%. The results of the third Prevalence Survey of Healthcare Associated Infections in Acute Hospitals 2006[2] showed a rate of 8.2% for England. This compares to rates of 9.2 and 9% in 1980 and 1993/4, although the methodologies between these prevalence surveys were not strictly comparable. This compares to an overall prevalence of 9.5% for Scotland and 7.6% for England, Wales, Northern Ireland and the Republic of Ireland (RoI) together (2006 survey). However, even within this joint prevalence survey across the UK and RoI, there were differences in approach which could affect the comparability of the results between the countries or Administrations. Participation by all hospitals in some of the smaller Administrations meant that they accounted for a disproportionate amount of the surveyed patients relative to size of population, which could impact on the interpretation of the results.

Concern about the proportion of *S. aureus* bacteraemias caused by MRSA in England compared to that in other European countries was one of the factors driving mandatory surveillance of HCAI. However, few countries undertake mandatory surveillance of HCAI and, of those that do, methodologies differ, making direct comparisons difficult. When surveillance is not mandatory, ascertainment biases become important; those that participate in surveillance programmes are often the enthusiasts, so the data from units with poorer infection records are not included in analyses. This can be particularly notable when trying to compare MRSA bacteraemia rates internationally. *C. difficile* infection rates in this country are undoubtedly high, but again it is difficult to get a clear picture of how this compares to other countries although the increase in reported cases is similar to recent increases in *C.difficile* associated disease in the USA and Canada. The recent HCAI prevalence survey in UK and RoI gave some indications that the rate of *C. difficile* infection was higher in England, although this requires more detailed analysis.

Comparisons are easier where there is more harmonisation in the collection of HCAI data, as for surgical site infections in participating European countries. England is one of the largest contributors to European surgical site infection surveillance, second only to Germany. English rates of infection are comparable to those reported elsewhere in Europe and for certain procedures, such as hip and knee prosthesis, are lower than the rest of the UK. Furthermore, there has been a statistically significant decrease in the rate of surgical site infection in the three main orthopaedic categories since 2004.

HCAI is an area of growing interest to the European Centre for Disease Prevention and Control (ECDC), with HCAI being the main theme for the forthcoming Annual Epidemiological Review.

What are the gaps?

Progress is being made in addressing gaps identified previously in the surveillance of HCAI: web-enabled systems are being developed to include post-discharge surveillance

of surgical site infection and reporting of HCAI outbreaks. Both of these have been a growing necessity, the former becoming more important as the length of admission after surgery has been decreasing rapidly over recent years, making data based on infections presenting during the admission an underestimate. Although reporting of serious untoward incidents associated with infection (including outbreaks) was highlighted by the Chief Medical Officer in 2003, the earlier reporting mechanism did not deliver adequate information on incidents and outbreaks of infection and lessons learnt from them. It is anticipated that a new system with functionalities based on those developed for mandatory MRSA bacteraemia and *C. difficile* infection surveillance will improve reporting and alert relevant personnel.

However, some gaps remain. The Steering Group on HCAI (SG-HCAI) made recommendations for further developments in HCAI surveillance in its final report[3]. Key outstanding ones include: a wider selection of index operations for mandatory surgical site infection surveillance and development of surveillance focussing on special groups of patients, such as those in Critical Care Units (adult, paediatric and neonatal), oncology and the immuno-compromised. Furthermore, the need to broaden surveillance across the whole health economy was identified. Certain micro-organisms were deemed to require further attention: ESBL-producers, PVL-producing *S. aureus* and *Acinetobacter spp*.

In addition, the results of the national prevalence survey of HCAI in acute hospitals in 2006 indicate areas warranting further attention: the most common infections were gastrointestinal infections, urinary tract infections, surgical site infections and pneumonia, whereas the specialties with the highest prevalence rates were those dealing with transplantation, critical care and high dependency care. Outstanding infections requiring targeting of surveillance in the light of these findings are infections in catheterised patients, norovirus infections and infections in special units, such as critical care and high dependency units.

Other areas requiring attention include the development of surveillance of antimicrobial prescribing in hospitals, routine monitoring of case fatality rates and external validation of reported data.

The HPA has made major contributions to identifying these priorities for action and prepared proposals on how to develop and implement these initiatives, which need to be embedded in national strategy and policy.

What's on the horizon?

The rise of infections with PVL-producing strains of *S. aureus* in some countries, such as USA, has been causing much anxiety. Some of these strains have made the transition from causing infections in the community to spreading in hospitals. Initiatives have been taken to raise the awareness of these infections in England and there is continuing vigilance of isolates referred to the Reference Laboratory. However, more robust surveillance is required to ensure that there is early warning of any changes in the epidemiology of these infections in this country.

The increase in multi-resistance in *E. coli*, though not necessarily healthcare-associated, continues to cause concern, whilst some traditional opportunist pathogens, such as *Acinetobacter* spp, have an increasing role as the population of patients vulnerable to infection through their illness or its treatment grows.

Key Points

Bloodstream infections:

• Bloodstream infections provide a robust measure of trends in serious infections due to bacteria and fungi as there is a long-established voluntary reporting system with good microbiology laboratory participation across the NHS. Not all bloodstream infections are healthcare-associated, but the overall picture of bloodstream infections provides a useful context for those which are associated with healthcare. The Department of Health's programme of mandatory national surveillance for certain HCAI has strengthened reporting of bloodstream infections due to meticillin-resistant *Staphylococcus aureus* (MRSA) and glycopeptide-resistant enterococci.

• *Escherichia coli* remains the most frequently reported cause of bloodstream infection.

• Bloodstream infections caused by *S. aureus* have continued to decline.

• Bloodstream infections caused by coagulase-negative staphylococci have shown the greatest increases since 2005. It is unclear how much of this is due to changing ascertainment and clinically significant infections.

• *Listeria monocytogenes* only accounts for a small number of bloodstream infections, but the clinical presentation is changing to bloodstream infection without central nervous system involvement, particularly in those aged 60 and over.

• More information on trends and antimicrobial susceptibilities of individual pathogens wil be available shortly in the partner report "Antimicrobial Resistance and Prescribing in England, Wales and Northern Ireland, 2008".

Mandatory surveillance of *Staphylococcus aureus* bloodstream infection:

• Rates of MRSA bloodstream infections have continued to fall over the past year, making it likely that the national target of a 50% reduction in numbers on the 2003/4 figures will be met.

• Rates are falling in all regions, with the greatest overall reduction in the London region, and in the four main Trust categories (small, medium, large, and teaching), with reductions from a range of 1.3 to 2.4 infections/10 000 bed days in the first six months of the surveillance in 2001 to a range of 0.96 to 1.2 in October to March 2008. Acute teaching Trusts had the highest rate and have shown the biggest reductions.

• MRSA bloodstream infection occurs more frequently among men (64%) and those aged 60 years and over (76%).

• Almost two thirds of MRSA bloodstream infections in the past two years were detected two or more days after admission to the reporting Trust, indicating the infections were likely to have been acquired during the hospital admission; just under a third (29%) were detected within two days of admission, with a further 6% being detected on presentation to A&E, outpatients or in regular attenders.

• Approximately a quarter (26%) of patients whose MRSA bloodstream infection was detected within 2 days of admission were admitted directly from either another hospital or a nursing home compared to 17% for those detected two or more days after admission.

• Almost 40% of infections which were likely to have been acquired during the admission occurred in general medicine. However, when rates were compared between the ten most commonly reported specialties, nephrology had the highest rate of blood-stream infections and trauma and orthopaedics the lowest.

• Certain treatment areas such as critical care units and high dependency units are classed as "augmented care". For patients likely to have acquired MRSA bloodstream infection in hospital, the most commonly cited augmented care location was the general intensive care unit.

Enhanced surveillance of MRSA bacteraemia in children:

• MRSA bloodstream infection in children remains rare in contrast to the situation in adults.

• The majority of infections occurred in premature babies and very young children, many of whom had underlying conditions which made them more vulnerable to infection.

• Most infections were associated with hospital strains of MRSA, in contrast to the situation in other countries where community strains are emerging in this age group.

Mandatory surveillance of Glycopeptide-resistant enterococcal (GRE) bloodstream infections:

• A total of 910 GRE bloodstream infection reports were made for the period October 2006 to September 2007, similar to the figure (903) reported for the same period in the previous year.

• The proportion of NHS acute Trusts reporting one or more of these bloodstream infections has reduced from 76% in 2005/06 to 69% in 2006/7. Fifty-two Trusts reported no bloodstream infections with these micro-organisms; a reduction on the 74 Trusts reporting no infections in 2003/4.

• Twenty-four Trusts reported more than 10 GRE bloodstream infections, which is the highest number reported since mandatory surveillance began in 2003/4.

• 55% of GRE bloodstream infections were reported from acute teaching Trusts during 2006/7.

Norovirus:

• Noroviruses are the most commonly detected pathogen in sporadic cases and outbreaks of gastroenteritis.

• They are highly infectious, infections occurring in community and hospital settings.

• Noroviruses in healthcare settings have a strong wintertime seasonality.

• Outbreaks in healthcare settings are disruptive and in epidemic years may cost the NHS inpatient services in excess of £100m.

• Intensive control measures are needed to prevent spread in hospitals.

• There is currently no national surveillance scheme for norovirus.

• The emergence of new variants within the predominant genogroup is associated with larger than normal epidemic seasons.

• This year's norovirus season started uncharacteristically early in October 2007; the highest number of laboratory reports ever received were recorded in the second week of 2008.

Mandatory surveillance of *C. difficile* infection:

• Mandatory reporting of *C. difficile* has recently undergone a period of significant change. Data from the current financial year (April 2007 – March 2008) will provide important baseline information for monitoring against the new target.

• The number of cases of *C. difficile* in people aged 65 years and over has decreased by 9% in 2007 compared to 2006, this is in contrast to rising *C. difficile* numbers between 2004 and 2006.

• The first fall in *C. difficile* infections has also been seen across regions and Trust types. Rates are highest in small acute Trusts.

• 82% of *C. difficile* infections occur in the 65 and over age group.

Information from *Clostridium difficile* isolates referred for typing in England:

• Mandatory surveillance of *C. difficile* infection also includes a sampling programme, whereby acute NHS Trusts are allocated a period in which to send microbiological samples which are positive for *C. difficile* for further microbiological investigations (typing and susceptibility testing).

• Trust laboratories also refer samples for investigation when there are concerns about increased numbers of cases, unusual severity etc. The median age of patients with referred specimens was 80 yrs.

• These are different systems, but both are indicating similar changes in the distribution of types of *C. difficile* in England: an increase in ribotype 027, now the most common ribotype in England, and declines in Types 001 and 106. Type 027 is the most common ribotype in all regions except the North East, where 001 still predominates, and Yorkshire and Humber, where they are at similar levels, although 027 appears to be beginning to overtake 001.

• There is no evidence of resistance to the mainstays of *C. difficile* treatment, vancomycin and metronidazole.

Surveillance of surgical site infection:

• There has been growing participation in surgical site infection (SSI) surveillance since January 2003, with 224 hospitals collecting data on 83 444 surgical procedures across 10 categories of surgery in 2007. 898 SSIs were identified.

• There is evidence of a continued downward trend in rates of SSI in most categories of surgical procedure; the risk of SSI has decreased significantly in hip & knee replacement surgery and hip arthroplasty.

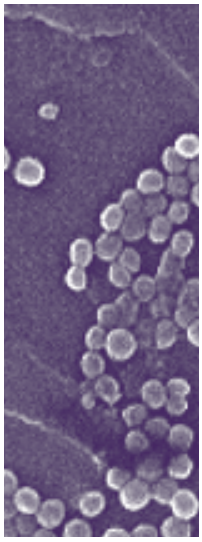
• The risk of SSI varied by surgical category, being highest in procedures involving the bowel where the likelihood of micro-organisms contaminating the operative site is high, and lowest in prosthetic hip and knee replacements where the risk of microbial contamination is low.

• The risk of SSI is also affected by patient and operation factors; older patients are at significantly increased risk.

• The majority of SSIs affected the superficial tissues, but approximately one third were more serious, deep infections.

• *S. aureus* is the most common micro-organism causing SSI and MRSA continues to account for a high proportion of these infections (64%).

• Work is under way to extend surveillance of SSI to include the period after discharge from hospital.



1 Bloodstream Infections

1.1. Introduction

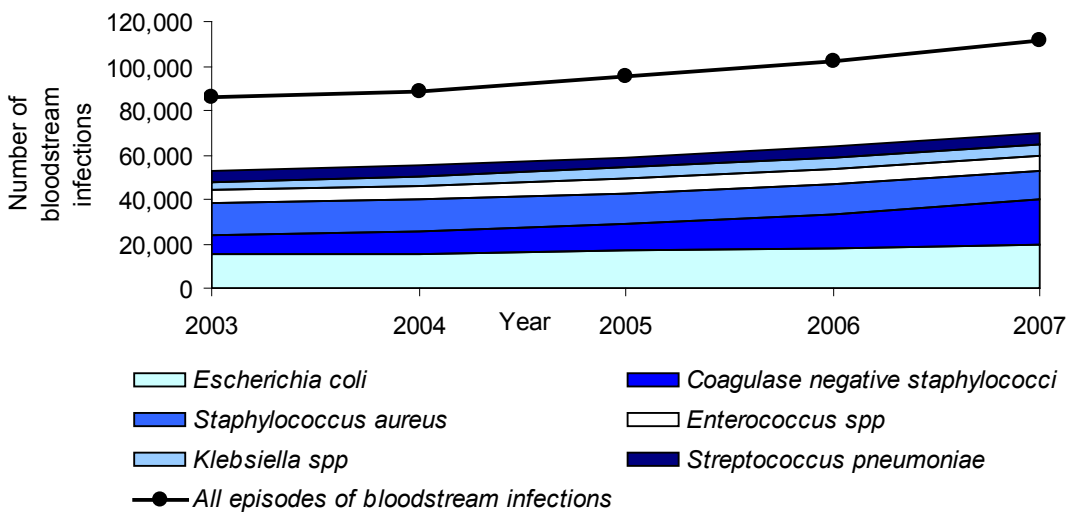
Bloodstream infections are an important source of surveillance information as they represent the severe end of the spectrum of infection. Indications for taking blood cultures and methods used to detect the responsible micro-organisms are more consistent than for many other clinical specimens taken to diagnose infection, thus providing a more robust basis for surveillance.
The majority of NHS acute Trusts in the country have participated in voluntary surveillance of key infections for many years. These data form the bedrock of national surveillance of infection and provide valuable information on infection trends over time. Analyses for the main pathogens causing bloodstream infections are published on the HPA website monthly (accessible from the HPA's 'Topics: A to Z' website[4]). This reporting system was strengthened with the introduction of mandatory reporting of *Staphylococcus aureus,* including meticillin-resistant *Staphylococcus aureus* bacteraemia, in 2001 and was later extended to glycopeptide-resistant enterococcal (GRE) bacteraemia in 2003.

This section of the Annual Report describes the incidence and identification of bloodstream infections in England from 2003 to 2007, focusing on changing trends in bloodstream infections particularly those caused by *S. aureus* and GRE. It must be remembered that not all bloodstream infections are associated with healthcare.

1.2. Trends in bloodstream infections in England, 2003 to 2007

The total number of positive blood cultures differs between the mandatory and voluntary surveillance systems. This is probably due to the removal of positive specimens which are not considered clinically significant from voluntary reports, as well as incomplete national participation in voluntary surveillance. However these data are invaluable for determining trends for the most frequently reported pathogens isolated from blood. *Escherichia coli* continues as the most common cause of reported bloodstream infections. Over the past 5 years there has been a fall in the proportion of bloodstream infections caused by *S. aureus*, with an equivalent rise in those caused by coagulase-negative staphylococci (CNS). Since 2003, the greatest increases in bloodstream infection have been reported for CNS (Figure 1).

Figure 1: Bloodstream infections in England, 2003 to 2007 (voluntary surveillance)

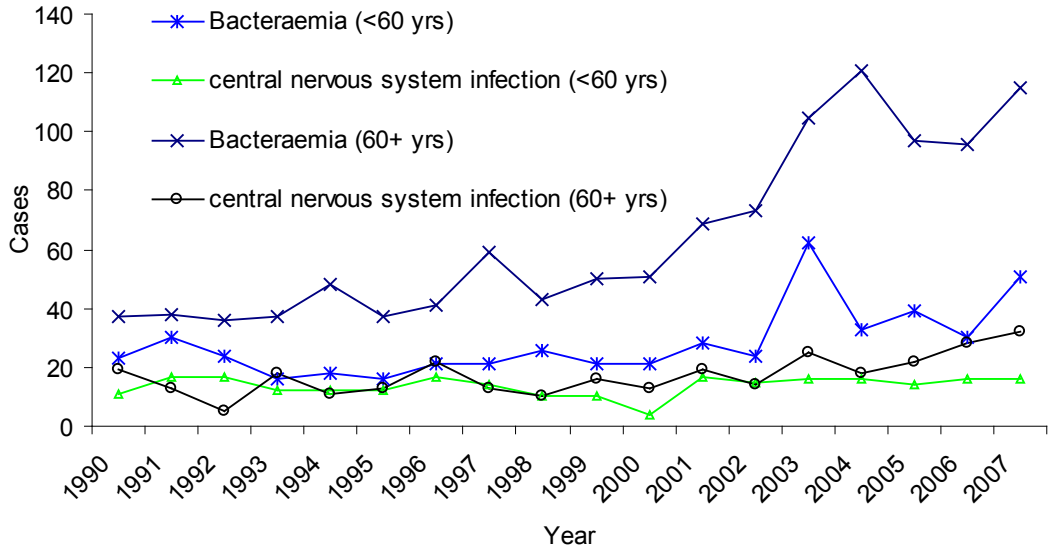


The increase in coagulase negative staphylococci (CNS) bloodstream infection reports is difficult to interpret. Traditionally, blood cultures testing positive for CNS have been dismissed as contaminants because CNS are frequently found among the normal and harmless flora of human skin. In the past few years the potential pathogenicity of CNS – especially as regards infections associated with medical devices such as prosthetic heart valves and intravenous catheters – has been increasingly recognised. The increase in these reported infections may be due, in part, to microbiologists' increasing tendency to consider CNS bacteraemia as clinically significant, however further investigation is required in order to accurately interpret the observed rise.

During the period 2003 to 2007 there has been a 37% increase in the number of bloodstream infections associated with *Candida* species with a total of 1272 reports in 2003 and 1740 reports in 2007. Conversely numbers of *Streptococcus pneumoniae* bloodstream infections have reduced by 13% over the same period from 5135 reports in 2003 to 4463 reports in 2007.

At the opposite end of the spectrum, there is a changing trend in bloodstream infections due to *Listeria*. *Listeria monocytogenes* only accounts for a small number of bloodstream infections, but this is becoming the most common presentation of listeriosis, accounting for 73% (166) of cases in 2007. This increase was more notable in patients aged sixty years and over (Figure 2). The observed pattern of listeriosis in England and Wales has changed since 2001. There has been an increase in the number of cases reported (an average of 185 cases reported annually between 2001 and 2006 compared with 109 cases between 1990 and 2000), especially in patients aged 60 years and over. The clinical presentation has also changed, with more cases presenting with bloodstream infection in the absence of central nervous system involvement. Mortality is high in all patient groups. Similar patterns have been reported in other European countries.

Figure 2. Clinical presentation by age group for cases of *L.monocytogenes* infection. England and Wales, 1990-2007 (N=2214)

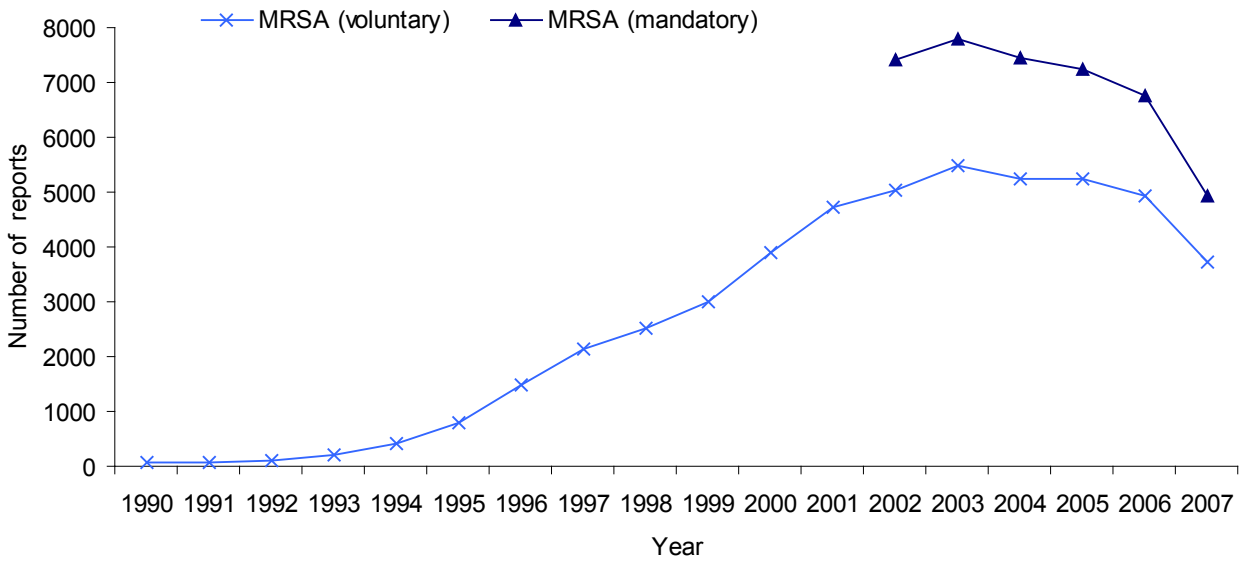


1.3. National trends in MRSA bloodstream infections

These data include information on MRSA bloodstream infections from both the original voluntary reporting system and the more recent national mandatory surveillance program. Figure 3 shows the trend in MRSA bloodstream infections since 1990 and the impact of mandatory surveillance in 2001. The increase in the number of bloodstream infections prior to the mandatory system is likely to reflect changes in ascertainment as well as increases in the number of MRSA bloodstream infections. The advent of the mandatory system has shown that approximately 70% of the isolates reported to the mandatory system were also reported through the voluntary scheme each year from 2002 to 2006. The discrepancy may be due in part to differences in case definition between the two systems, as well as incomplete national participation in the voluntary reporting system. Since 2003, there has been a downward trend in MRSA bloodstream infections in both the mandatory and voluntary systems. The reduction in MRSA bloodstream infections indicates that the national target of a 50% reduction on the 2003/4 figures is likely to be met in 2008.

The mandatory surveillance data for MSSA bloodstream infections are not as robust as those for MRSA bloodstream infections. Preliminary evidence indicates changes to the epidemiology of MSSA. These issues are being investigated with a view to publication later in the year.

Figure 3: Meticillin-resistant *Staphylococcus aureus* bloodstream infection reports received under the voluntary and mandatory schemes in England, calendar year 1990 to 2007

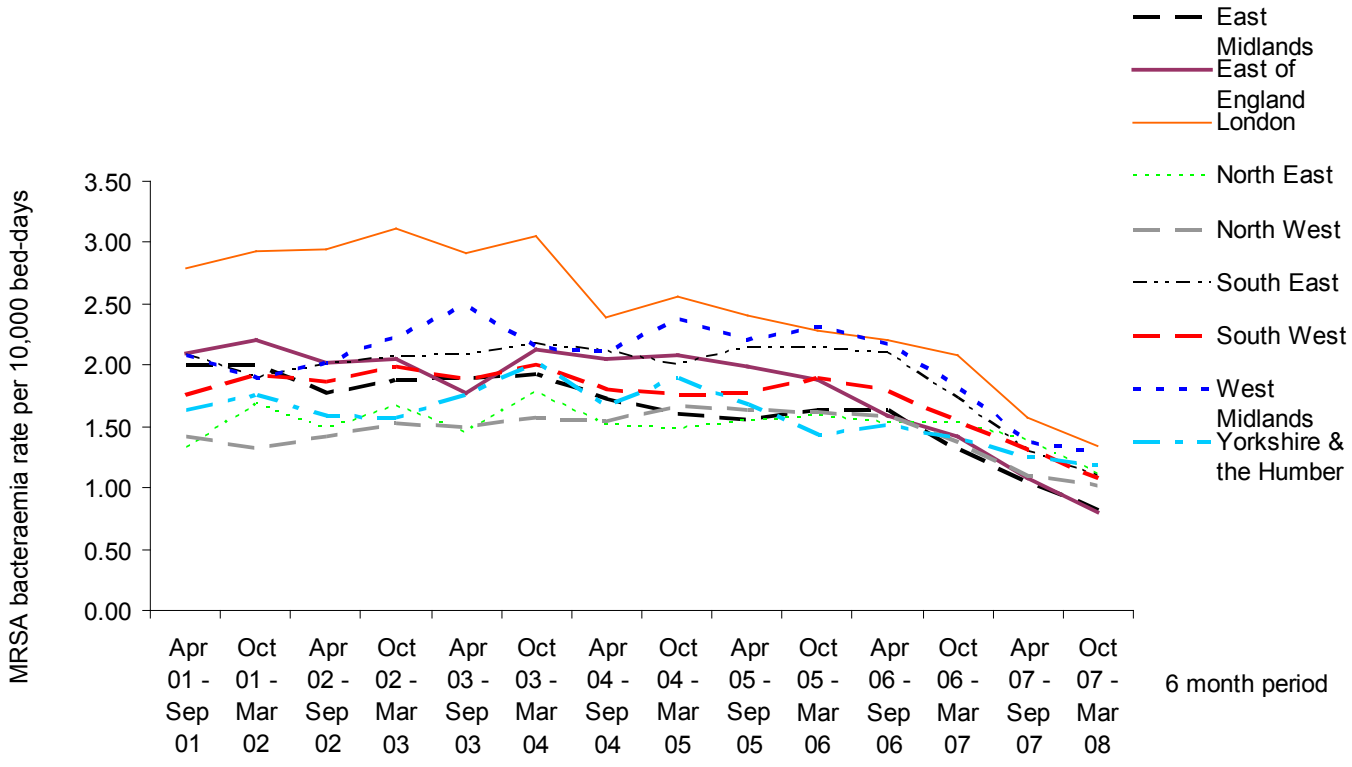


1.4. Regional and Trust trends in MRSA bloodstream infections since 2001

1.4.1. Regional trend

During the period April 2001 to March 2008, 47 567 reports of MRSA bloodstream infections were received from acute Trusts in the nine HPA regions. Regional rates of MRSA bloodstream infection/10 000 bed days have reduced from a range of 1.33 – 2.79 in April – September 2001 to a range of 0.82 – 1.34 in October – March 2008 (Figure 4). The London region, which has a large proportion of acute teaching hospitals, has had the greatest number of reported MRSA bloodstream infections for all years of the reporting scheme but also shows the greatest overall reduction.

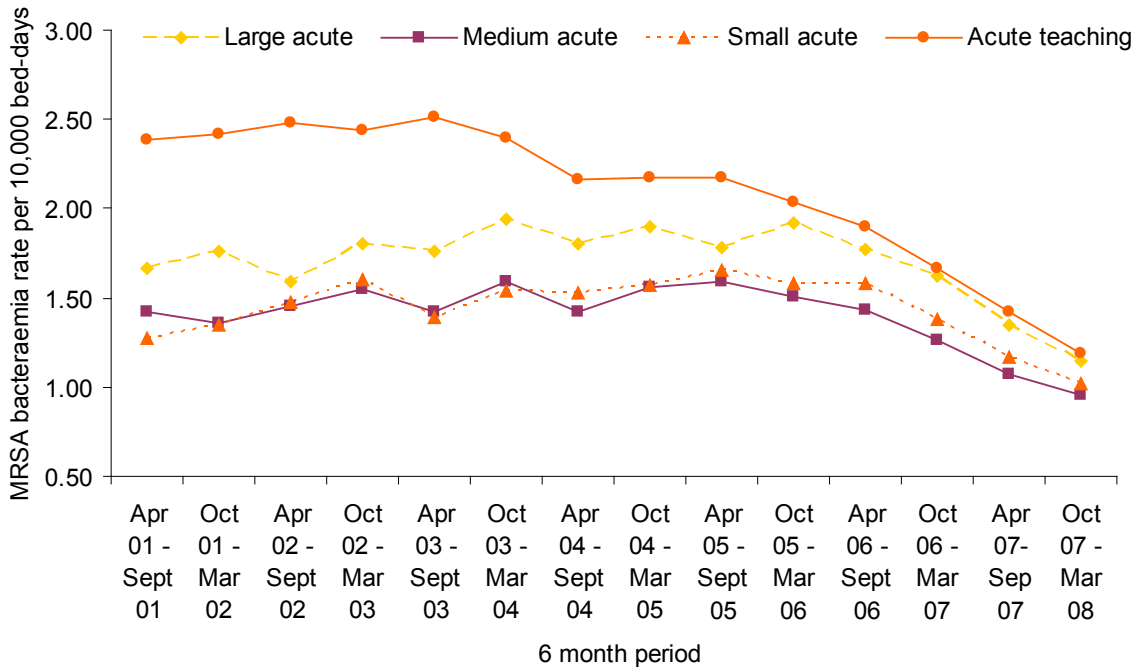
Figure 4: Regional distribution of MRSA bloodstream infection rates, April 2001 to March 2008



1.4.2. Trend by type of Trust

Figure 5 shows the MRSA bloodstream infection rates by four Trust categories (see appendix 3 for a glossary of Trust categories). There have been reductions in MRSA bloodstream infection rates in all of these Trust categories in the past year. Rates have consistently been highest in the four non-specialist acute Trust categories (small, medium, large, and teaching) throughout the surveillance period. These four Trust types account for almost 90% of all Trusts. Greatest improvements have been seen in these Trust types, with rate reductions from a range of 1.27 to 2.40 in April – September 2001 to a range of 0.96 to 1.19 infections/10 000 bed days in October - March 2008. Two trust categories, specialist and specialist children, were not presented as they show wide variations in rates owing to the relatively small numbers of cases reported from these trust types.

Figure 5: MRSA bloodstream infection rate by trust category, April 2001 to March 2008



1.5. Enhanced surveillance of bloodstream infections

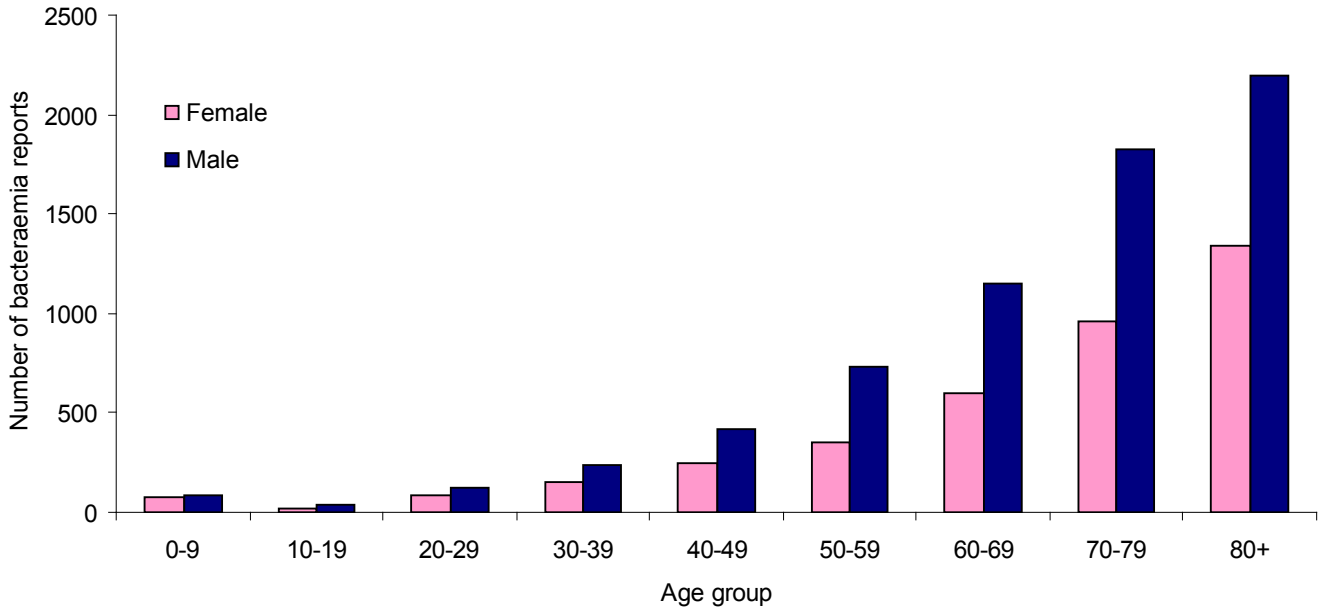
Enhancements to MRSA bloodstream infection surveillance were introduced in October 2005, as required by the Department of Health. These enhancements included additional information about each infection episode, such as patient demographics, information on the patient's location, date of admission and care details at the time the blood culture was taken.

This section of the report provides some analysis of these enhanced data for the period April 2006 to March 2008, during which time a total of 10 821 cases were reported. Since May 2006 Trusts have been able to report additional data on patients' risk factors for MRSA bloodstream infection, such as exposure to invasive devices, significant co-morbidities, previous healthcare interactions and presumptive source. At present these data are collected on a voluntary basis and analysis of data collected to date is in progress.

1.5.1. Age and sex distribution (April 2006 – March 2008)

Information on the age and sex distribution of patients diagnosed with MRSA bloodstream infection was available for 98% of reports (10 656 reports) between April 2006 and March 2008 (Figure 6). The number of reported cases increased with age and was greater among males (64%). Seventy-six percent of cases occurred among those aged 60 years and over. The mean age for the two year period, both sexes combined, was 69 years.

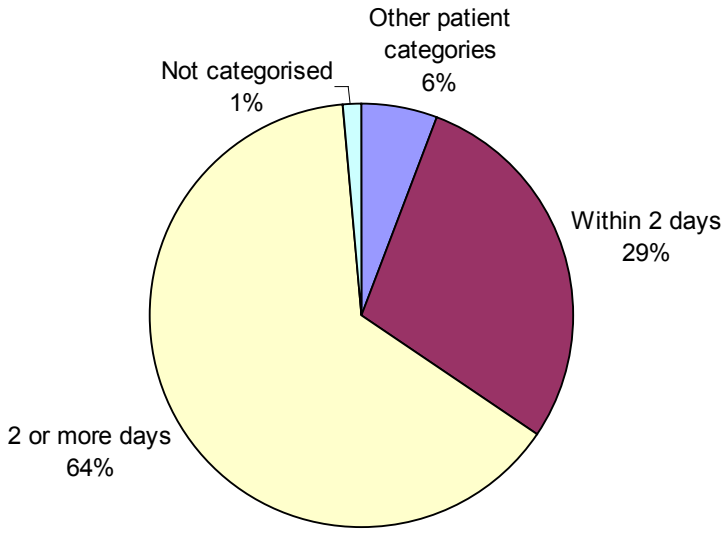
Figure 6: Age and sex distribution, April 2006-March 2008



1.5.2. Timing of detection and patient location prior to admission (October 2005 – March 2008)

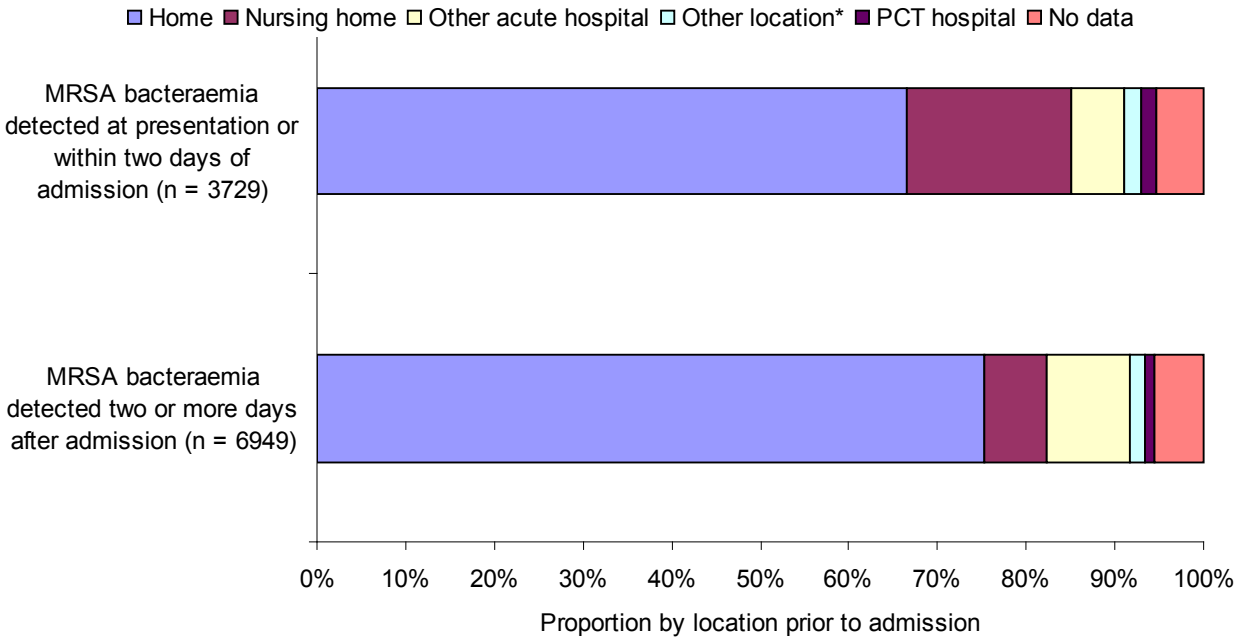
Almost two thirds (64%) of MRSA bloodstream infections were detected two or more days after admission, indicating that they were most likely acquired during that particular admission (Figure 7). The majority of these patients (75%) were admitted from home, with a further 10% admitted from another acute or PCT hospital and 7% admitted from nursing homes (Figure 8).

Figure 7: Timing of detection of MRSA bloodstream infection in relation to presentation of patient to reporting Trust, April 2006 to March 2008



A little less than one-third (29%) of MRSA bloodstream infections were identified within two days of admission, indicating that these were unlikely to have been acquired during that specific admission. A further 6% of cases were detected in patients not admitted at the time the blood specimen was taken (this group comprises regular attenders, accident and emergency patients and outpatients) (Figure 7). Analysis of the patients' location prior to admission showed that, as with the group acquiring their infection during the hospital admission, the majority (67%) of this group were admitted from home, but a further 18% were admitted from nursing homes and 8% from another acute or PCT hospital (Figure 8). It is not possible to infer the percentage of community-acquired MRSA bloodstream infections from these data, as bloodstream infections incubating at the time of admission may have been associated with prior healthcare contact. Reliable information on prior healthcare contact is currently not available.

Figure 8: Patient location prior to admission for patients with MRSA bloodstream infection, April 2006 to March 2008 (n=10678)

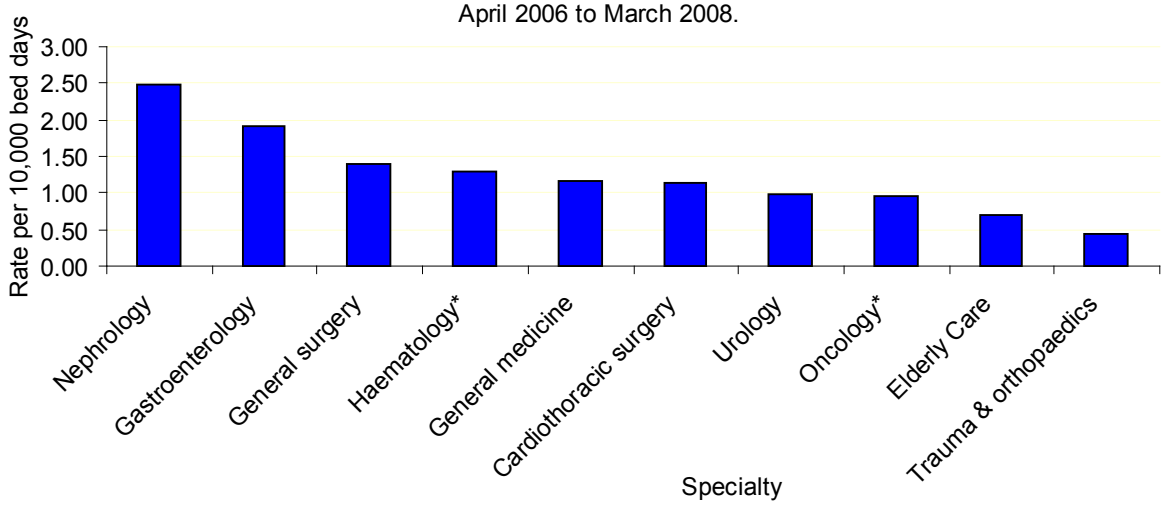


*Other location includes penal establishments, private hospitals, and temporary accommodation.

1.5.3. MRSA bloodstream infection by hospital specialty

MRSA bloodstream infection by hospital specialty was analysed for those records where MRSA was detected two or more days after admission i.e. the bacteraemia was likely to have been acquired during that hospital admission. Rates per 10 000 bed days were calculated for the ten most commonly reported specialties during the period April 2006 to March 2008, using Hospital Episode Statistics (HES) data for the period 2005/6 and 2006/7 (Figure 9). Specialties with the highest rates were nephrology (2.48) and gastroenterology (1.90); those with the lowest rates were trauma and orthopaedics (0.43) and elderly care (0.69). It is important to note that high rates are not necessarily indicative of a high MRSA bloodstream infection count; rather they demonstrate a higher proportion of MRSA bloodstream infections in relation to bed days within that specialty. Actual counts of bloodstream infections were highest in general medicine and general surgery, at 2416 and 1252 respectively. MRSA bacteraemia rates for these specialties are lower due to the higher number of admissions in these specialties.

Figure 9: MRSA bloodstream infection rate (per 10 000 bed days) by speciality, April 2006 to March 2008.

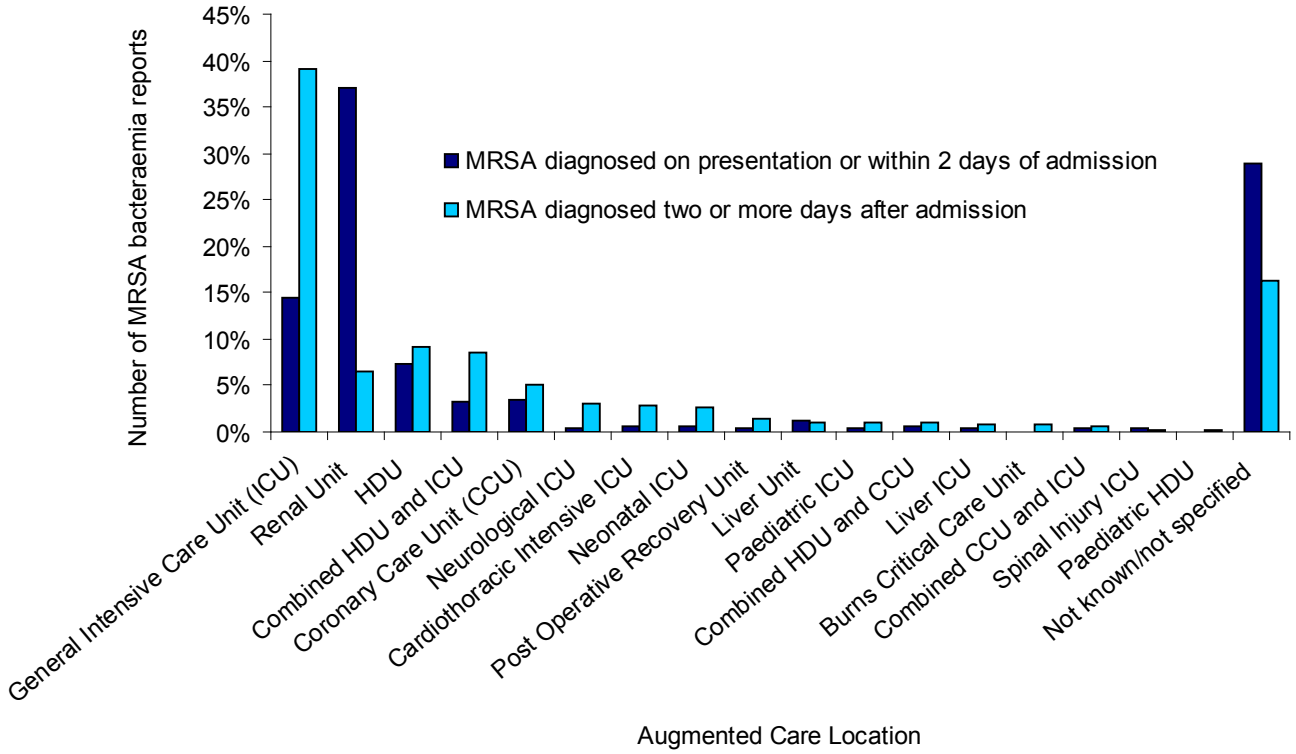


*Specialties clinical haematology & haematology and clinical oncology & medical oncology have been combined into haematology and oncology respectively

1.5.4. Augmented care location

A review of those records which indicated the patient was in an augmented care location at the time the specimen was collected was carried out (Figure 10). Between April 2006 and March 2008 a total of 2637 records included information on augmented care location. When MRSA bloodstream infection was detected within two days of admission the most frequently recorded augmented care location was renal units (37%). However, general intensive care units accounted for the most frequently recorded (39%) augmented care location when the infection was likely to have been acquired during the hospital admission. These data are presented as counts as denominator data to determine rates are currently not available.

Figure 10: Most commonly reported augmented care location for MRSA bacteraemia detected either within two days or two or more days after admission April 2006 - March 2008.



(ICU = Intensive Care Unit; CCU = Coronary Care Unit; HDU = High Dependency Unit)

1.6. MRSA bloodstream infections in children

A special two year study* has been undertaken to obtain a robust estimate of the incidence of MRSA bloodstream infection in children under 16 years in the UK and Ireland and to define the demographic and clinical features of the patient population in order to identify those children at high risk.

Comparisons with other data sources for bloodstream infection indicate that MRSA bloodstream infections in children comprise approximately 1-2 per cent of the total of such infections across all age groups. The study has shown that the majority of infections occurred in premature babies and very young children, many of whom have underlying conditions which made them more vulnerable to infection.

Most infections were associated with hospital strains of MRSA. This is in contrast to the changing epidemiological picture seen in other countries, particularly the USA, where high levels of infections with community strains of MRSA infections have emerged. These findings have significant relevance for the management and control of severe paediatric infections due to *S. aureus*. Identification of those groups of children who are at increased risk of developing MRSA blood stream infections should inform the development of rational strategies for the prevention and control of these infections.

1.7. Glycopeptide-Resistant Enterococcal (GRE) Bloodstream Infections

Reporting of clinically-significant GRE bloodstream infection has been mandatory for NHS acute Trusts in England since September 2003. There were 910 reports of GRE bloodstream infections from 118 NHS acute Trusts in England under the mandatory scheme between October 2006 and September 2007 (Table 1). This is similar to the number of reports (903) received between October 2005 and September 2006.

Table 1: GRE bloodstream infection reports received under the mandatory scheme in England

Reporting year	Number of GRE bacteraemia reports
October 2003 – September 2004	628
October 2004 – September 2005	757
October 2005 – September 2006	903
October 2006 – September 2007	910

The number of Trusts reporting more than 10 GRE bloodstream infections each year increased from 13 in the first year of mandatory surveillance to 24 in the latest full year. The majority (75%) of reports from Trusts reporting more than 10 GRE bloodstream infections were from acute teaching Trusts. The number reporting no GRE bloodstream infections has decreased from 74 in 2003/4 to 52 in 2006/7. The proportion of NHS acute Trusts reporting one or more of these bloodstream infections has reduced from 76% in 2005/06 to 69% in 2006/7 (Table 2).

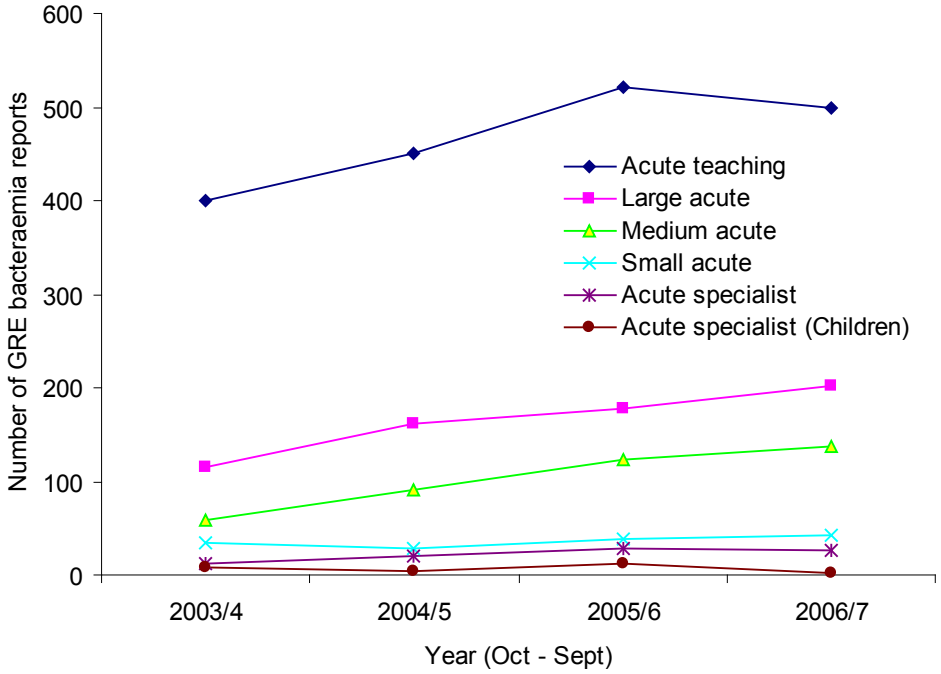
Table 2: Number of GRE bacteraemia reports per Trust, 2007

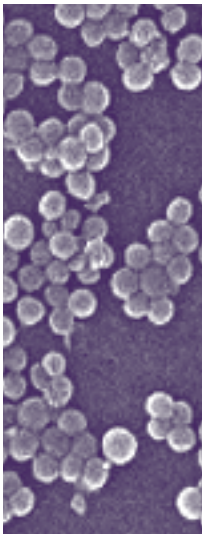
	Number of Trusts reporting 0, 1 to 10, or > 10 GRE bacteraemia reports		
Reporting year	0	1 to 10	> 10
October 2003 – September 2004	74	82	13
October 2004 – September 2005	55	94	21
October 2005 – September 2006	41	110	19
October 2006 – September 2007	52	94	24

*commissioned by the Department of Health and undertaken by the HPA in collaboration with The British Paediatric Surveillance Unit (BPSU), St George's Hospital (London), Health Protection Scotland and the Health Protection Surveillance Centre (Dublin). Nearing completion.

During the reporting period 2006/7 55% of GRE bloodstream infection reports were from acute teaching Trusts compared to 64% during 2003/4 (Figure 11). Reports from large acute Trusts accounted for 21% of reported cases in 2006/07, compared to 18% in 2003/4.

Figure 11: GRE bloodstream infections by Trust category 2003 to 2007





2 Gastrointestinal Infections

2.1. Norovirus infections

Noroviruses are the most commonly detected pathogen both in sporadic cases and outbreaks of gastroenteritis. They are particularly problematic in any environment where groups congregate and infection can be rapidly transmitted through both faecal and vomitus routes. Immunity to norovirus is not long lasting - somewhere in the range of 6 months - and is not broadly protective between genogroups. Furthermore, the virus is evolving and the emergence of variants that escape population immunity are associated with epidemic seasons. The relationship between community and nosocomial norovirus is not clear. In the community, infections are much less seasonal than in healthcare settings and, unlike in hospitals where a single genotype heavily predominates, there is wide viral diversity in the community. Outbreaks affect healthcare facilities worldwide, and may cause massive disruption to the provision of care, substantial economic loss, and, according to some reports, mortality in vulnerable patient populations.

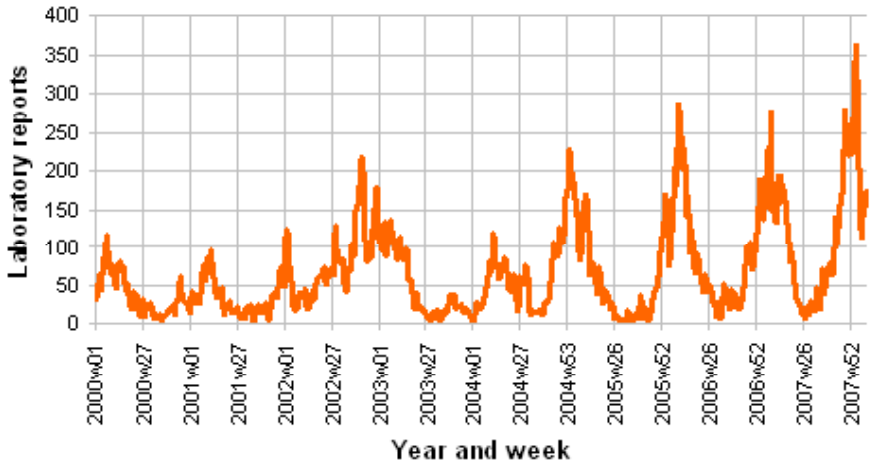
As is typical of positive-sense single-stranded RNA viruses, noroviruses are diverse and quickly evolving. There are two main genogroups affecting humans and approximately 15 genotypes within these groups, with substantial genetic heterogeneity between and within genogroups. A single type, genotype 4, belonging to genogroup II (GII-4), has been the predominant circulating virus since at least 1995. This genotype is particularly prevalent in healthcare settings where it causes over 90% of outbreaks. New variants within GII-4 emerge every 2 to 5 years, and are associated with larger-than-normal epidemic seasons.

There is currently no national scheme for the surveillance of norovirus outbreaks in hospitals, although an outbreak reporting system is being developed. However, focussed studies have demonstrated the exceedingly high incidence of such outbreaks, with wards being affected more than once a year, on average. The highly infectious nature of these viruses requires intensive control measures to prevent further spread. The mainstays of norovirus control are closing affected wards to new admissions and excluding affected staff during and for 48 hours after their symptomatic period. These measures are disruptive and, in epidemic years, may cost the NHS inpatient services in excess of £100m.

Noroviruses in healthcare settings have a strong wintertime seasonality (Figure 12). This year's norovirus season started uncharacteristically early in October 2007. The number of weekly laboratory reports peaked in the second week of 2008, which was the highest recorded number of norovirus laboratory reports ever received in a single week. Not all of these infections are healthcare associated.

New tools developed at the Centre for Infections, HPA, allow highly discriminating genetic typing of noroviruses in order to elucidate transmission routes and detect emerging virus variants.

Figure 12: Reports of laboratory confirmed norovirus gasteroenteritis, 2000 to 2007



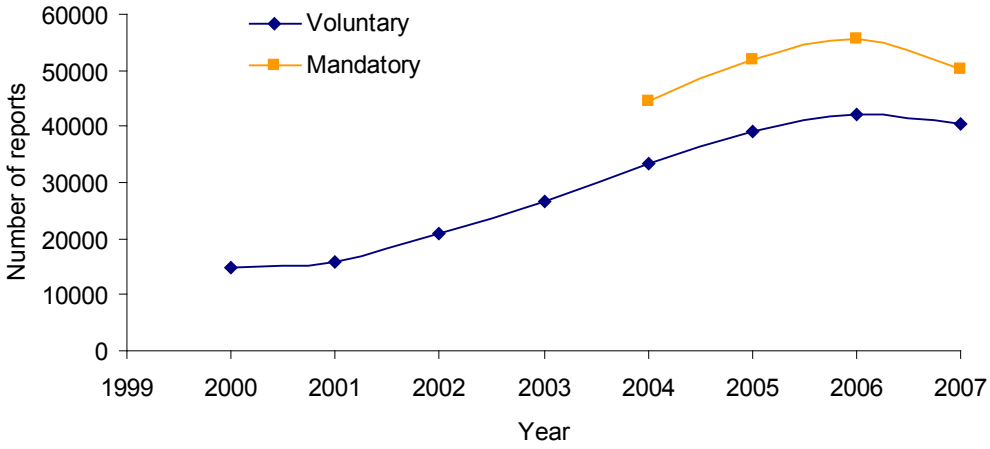
2.2. *Clostridium difficile* infection

2.2.1. National trend in *C. difficile* reports since 2000

NHS acute Trusts have participated in *C. difficile* infection surveillance on a voluntary basis for many years. However, surveillance in patients aged 65 years and over became mandatory in January 2004, which improved ascertainment levels by ~24-33%. There have been notable developments to the surveillance scheme over the past year to make it more robust and to enable monitoring of the new *C. difficile* target. From April 2007, *C. difficile* reporting has been completed via a web-enabled system, with expansion of data collection to include patients aged 2 years and over, in order to support improved monitoring of infection. Enhancements to the dataset and addition of certain fields (since April 2007) enable further investigation into age differences as well as into reports of *C. difficile* in non-acute settings. Data from the current financial year (April 2007-March 2008) will provide important baseline information for future analyses and the new *C. difficile* target.

The number of reports of *C. difficile* in patients aged 65 years and over rose steadily between 2000 and 2006 peaking in 2006, with 55 635 reports of *C. difficile* recorded via the mandatory and 42 253 via the voluntary surveillance systems (Figure 13). There had already been a large increase in reports of *C. difficile* infection prior to the start of mandatory surveillance, which probably reflected improved ascertainment (higher index of suspicion, newer tests, better reporting) as well as an increase in the number of infections. Between 2004 and 2005 there was an increase of 16% in *C. difficile* infection reports in patients aged 65 years and over reported via the mandatory surveillance system, followed by a 7% increase in 2005/6. However, the number of cases of *C. difficile* in people aged 65 years and over has decreased by 9% in 2007 compared to 2006. The decrease in reported cases of *C. difficile* should be interpreted with caution as this downward shift has occurred only during the last year. The establishment of national targets and increased emphasis on infection control measures in hospitals could signal a continued decrease in the incidence of *C. difficile*.

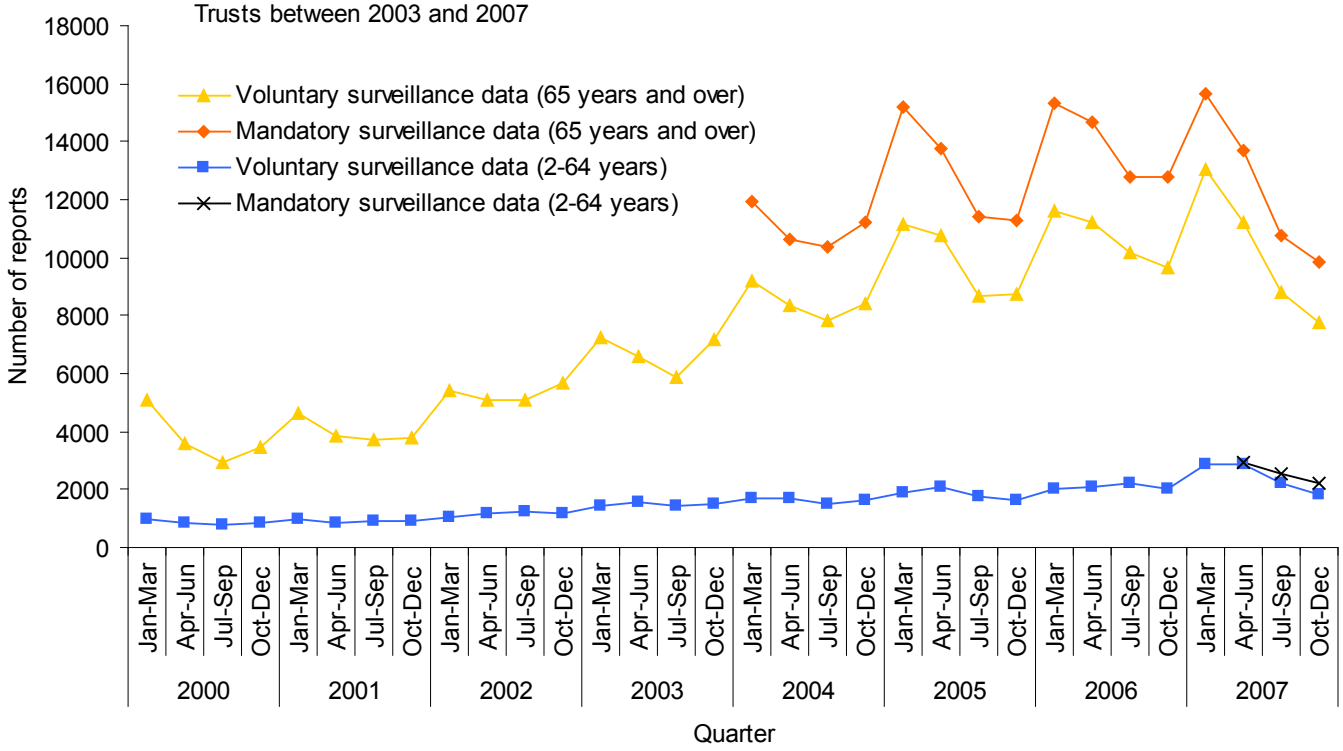
Figure 13: Trend in *C.difficile* reports for patients aged 65 years and over reported via the mandatory and voluntary reporting systems, 2000 to 2007



2.2.2. *C. difficile* seasonality

The data from both the mandatory surveillance system for *C. difficile* infection and the pre-existing voluntary system for patients aged 65 years and over showed peaks in reported case numbers in the January – March quarter of each year (Figure 14).

Figure 14: Quarterly number of reports of *C. difficile* infection received from English NHS acute Trusts between 2003 and 2007

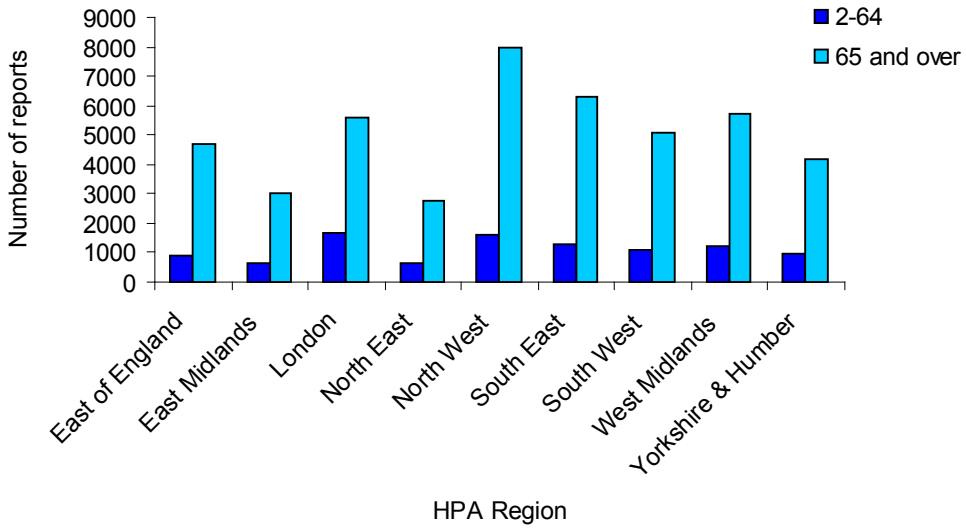


Analysis of the voluntary data shows that seasonality in the younger age group is much less pronounced than in the older age group. This suggests that seasonality is driven by one or more risk factors to which exposure is greater in the older age group. Possible risk factors include disproportionately large increases in hospital admissions and increased antibiotic usage in elderly patients during the winter.

2.2.3. Regional and Trust trends in *C. difficile* infection since 2004

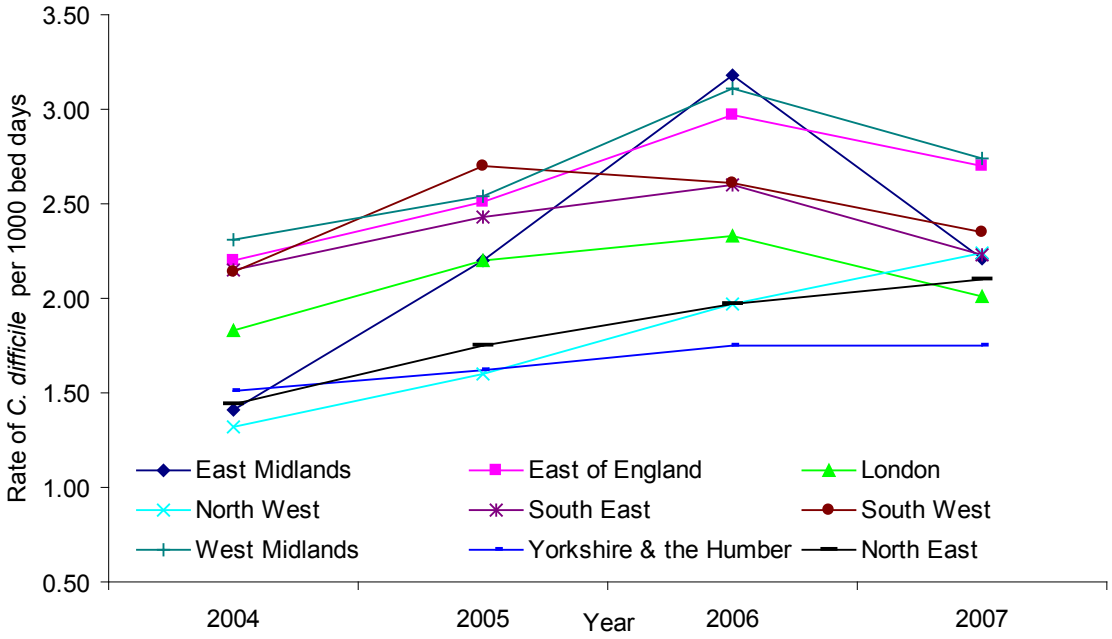
Results from the mandatory surveillance data for April 2007 to March 2008 show regional differences (Figure 15). The London region has the highest proportion of *C. difficile* infections in the 2 - 64 age range, at 23% of their total infections.

Figure 15: Regional reports of *C. difficile* infection by age group, April 2007 to March 2008 (mandatory surveillance)



Analysis of the rates of infection by region, in the age group 65 and over, shows that during the period 2004 to 2007, 202 419 reports of *C. difficile* infections were received from NHS acute Trusts in the nine regions (Figure 16). Rates of *C. difficile* infection/1000 bed days increased from a range of 1.32 – 2.31 in 2004 to a range of 1.75 – 2.74 in 2007, with rates peaking in most regions in 2006. Much of this increase is likely to reflect improved reporting of cases. There is currently only one year of data for the 2-64 age group so equivalent analysis cannot be undertaken yet.

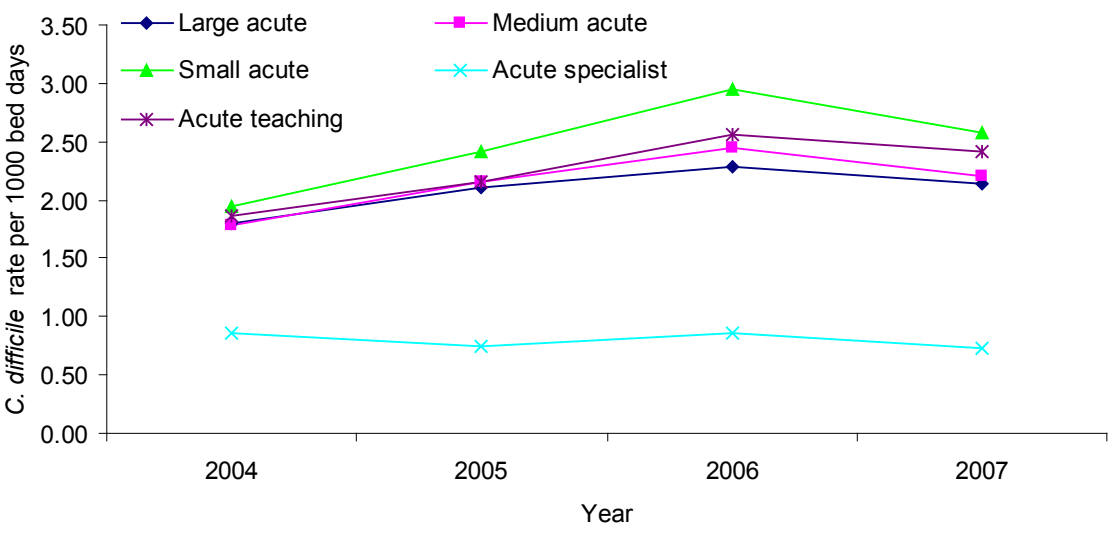
Figure 16: *C. difficile* rates per 1000 bed days by region 2004 to 2007
(mandatory surveillance in patients aged 65 years and over)



2.2.4. Trend by Trust type

Analysis of the *C. difficile* infection rates per 1000 bed days by Trust category for the age group 65 years and over shows that rates are highest in small acute Trusts and that there have been reductions in rate over the last year in all Trust categories (Figure 17). Rates have consistently been highest in the four non-specialist acute Trust categories (small, medium, large, and teaching) throughout the surveillance period. As previously noted these four Trust types account for almost 90% of all Trusts. Rates of *C. difficile* infection/1000 bed days have increased from a range of 0.86 – 1.95 in 2004 to a range of 0.72 – 2.58 in 2007.

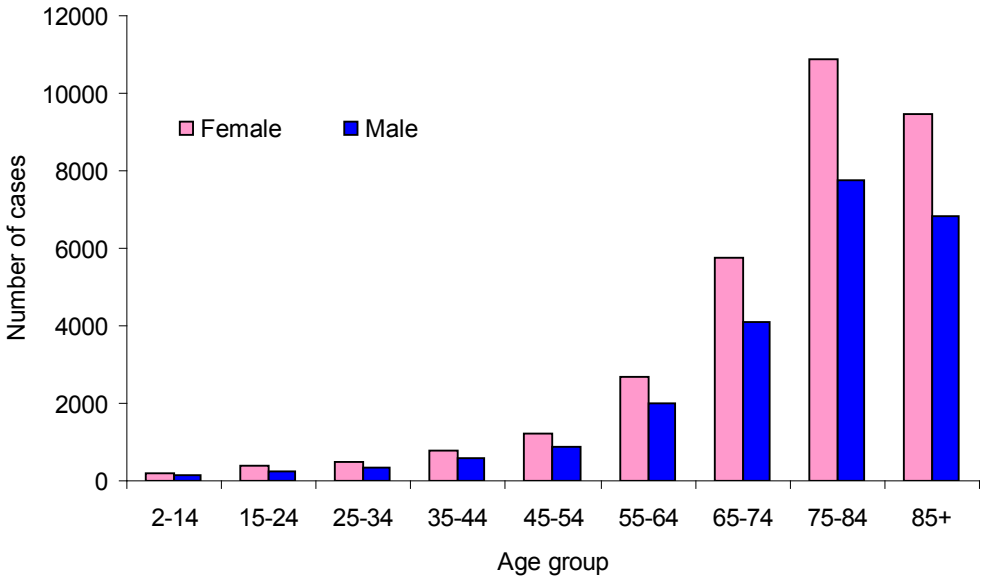
Figure 17: *C. difficile* rates per 1000 bed days by Trust category 2004 to 2007
(mandatory surveillance over 65 years)



2.2.5. Age and Sex Distribution

Mandatory surveillance was extended to the 2-64 years age group from April 2007. *C. difficile* infections in patients aged between 2 and 64 years account for 18% of all reported infections, the vast majority (82%) occurring in the 65 years and over age group (Figure 18). *C. difficile* infection shows marked variation between males and females with the majority of cases occurring in women (58%, 31 846 cases) compared to men (42%, 22 900 cases). The sex of the patient was unreported for approximately 1% (669 cases) of cases.

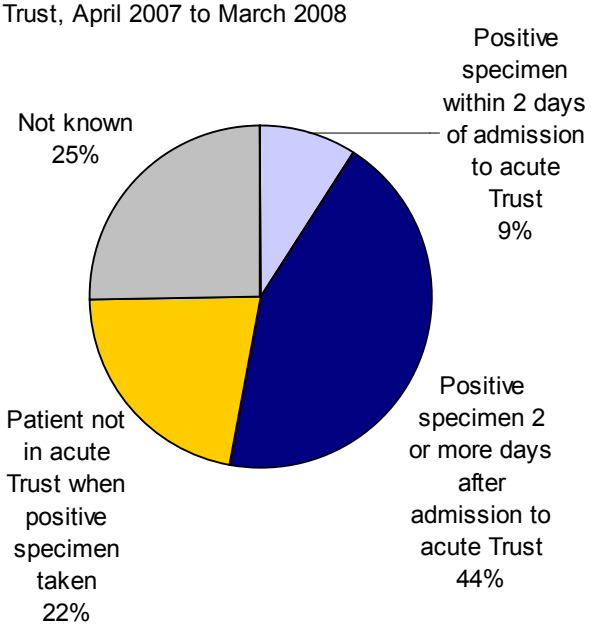
Figure 18: Age and sex distribution of *C. difficile* reports, April 2007 to March 2008 (mandatory surveillance)



2.2.6. Timing of detection and patient location when specimen taken

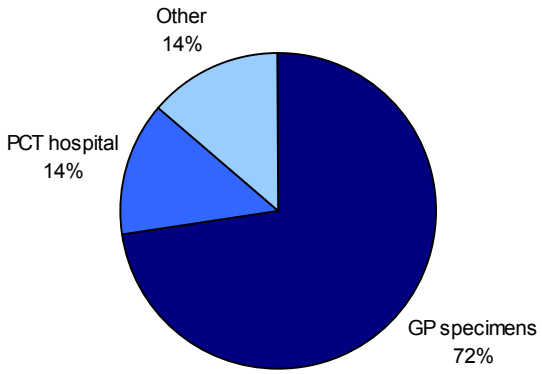
Timing of *C. difficile* detection provides information on when the *C. difficile* specimen was collected relative to the specific hospital admission. Forty-four percent (24 168 cases) of all reported *C. difficile* infections were detected two or more days after admission to the reporting Trust, indicating that the infections were likely to have been acquired during that hospital admission (Figure 19). Nine percent of cases were detected less than 2 days after admission to the Trust (for inpatients, emergency assessment and day patients). Other patient categories comprising A&E, regular attenders and outpatients made up less than 1% of specimens where the patient location and admission status were known. Patient location was not known in 25% of cases due to missing information (date of admission or location of patient when specimen taken).

Figure 19: Patient location when specimen taken in relation to presentation of the patient to the reporting acute Trust, April 2007 to March 2008



Twenty-two percent (12 062 cases) of *C. difficile* specimens were submitted from a location outside the acute Trust. The majority of these (73%) were submitted from a GP surgery (Figure 20). Specimens were also submitted from nursing homes, penal establishments and residential homes. There is also considerable variation by Trust type in the proportion of *C. difficile* specimens submitted from non-acute settings, with none of the 20 Specialist Trusts reporting *C. difficile* specimens submitted from outside acute hospitals. This is likely to reflect the case mix of different types of Trusts.

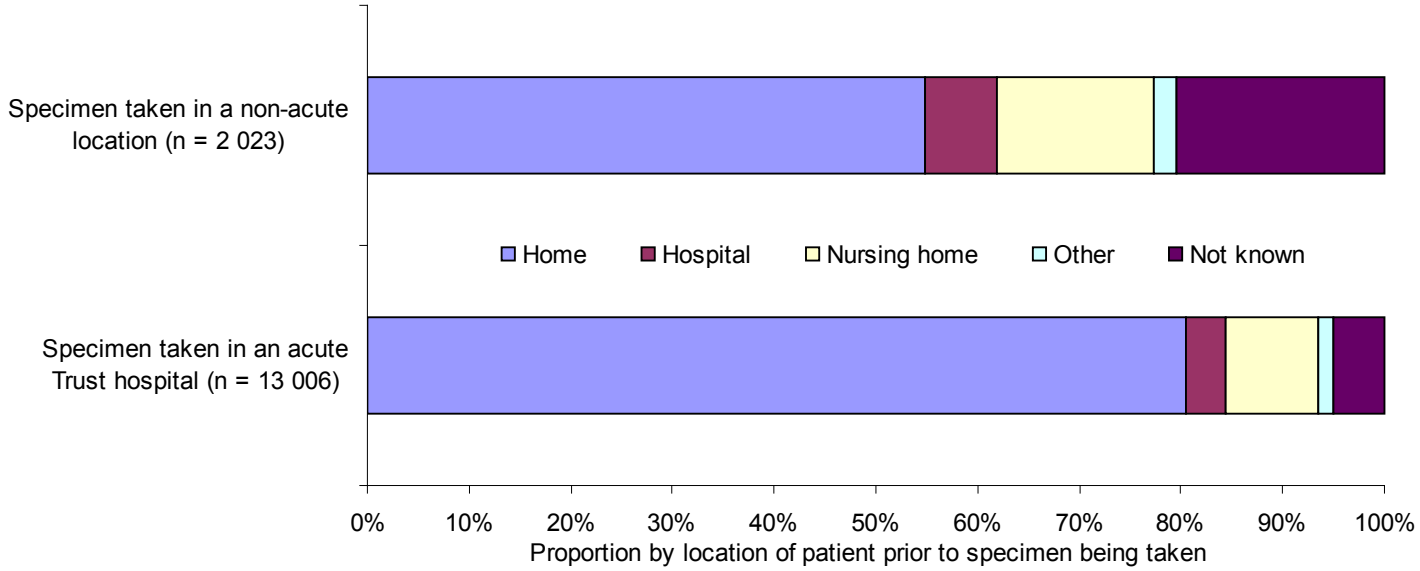
Figure 20: Location of patient when specimen was submitted from outside an acute Trust (n=12 062)



Submission of a specimen from outside an acute Trust does not necessarily mean that the infection was acquired in the community, as the patient may have recently had healthcare contact. Reliable information on prior healthcare contact is currently not available.

The location of the patient prior to the positive specimen being taken was known for 15 029 records (13 006 specimens taken in an acute Trust hospital and 2 023 specimens taken in a non-acute location) (Figure 21). The majority of patients had been at home, this proportion was higher in specimens taken in an acute Trust hospital (80%, 10 468 patients) compared to specimens submitted from outside an acute Trust, where a higher number had been in hospital or a nursing home (55%, 1 111 patients). The proportion of cases where the provenance of the patient was unknown is noticeably higher for specimens that were submitted from outside the acute trust than those where the patient was already in the Trust.

Figure 21: Patient location prior to *C. difficile* diagnosis: comparison of acute and non-acute locations April 2007-March 2008



2.2.7. Information from *Clostridium difficile* isolates referred for typing in England

This section of the chapter deals with the results of microbiological investigations when a positive *C. difficile* specimen is sent for typing. These referrals occur either (i) as part of the random sampling scheme (part of the mandatory surveillance of *C. difficile*) or (ii) when there are local concerns about *C. difficile* infections, for instance, increased frequency or severity. These are very different systems, but it is of note that both are showing similar changes in prevalent *C. difficile* ribotypes across England.

2.2.7.1. Sampling scheme for acute NHS Trusts

Concerns over reduced referrals for typing and the consequent lack of information regarding prevalent strains of *C. difficile* and antimicrobial susceptibilities led to the establishment of a sampling scheme whereby English acute NHS Trusts were allocated a week in which to send a defined number of patient stool samples positive for *C. difficile* toxins to the Reference Laboratory for PCR ribotyping and susceptibility testing.

The second year of this sampling scheme ran from 1st April 2007 to 31st March 2008. A total of 186 hospitals submitted 734 *C. difficile* toxin positive faecal samples, from which 677 isolates were recovered (recovery rate 92.2%). No submissions were received from 65 hospitals, 11 of these notifying nil returns. Specimens from one Trust (eight samples) could not be processed. Overall numbers of *C. difficile* isolates received were less than in the first year's sampling, when there were 881 isolates available for typing. Adherence to the sampling schedule was patchy, with over 50 hospitals sending in less than their allocated number of samples, whilst a very few sent more. The reasons for this are being investigated.

Although there were some small changes in methodology between the first and second year of the sampling scheme, these should not preclude a comparison of the main findings between the two surveys. Some changes in national and regional distributions of PCR ribotypes of *C. difficile* were evident comparing the two years of sampling (Figures 22 & 23). Nationwide, Type 027 is now the most common strain and has increased from 25.9% to 41.2% of the total number of isolates examined in the study. Type 027 has increased in number in six out of nine regions with slight reductions noted in the South East and North East, and no change in incidence in the South West. In contrast, Type 001 appears to be in general decline across nearly all regions of England, accounting for lower percentages than previously in eight out of nine regions. Only in the West Midlands did it account for a similar proportion as previously, whilst it was not found in the sample from Trusts in the East Midlands. Type 106 has declined slightly overall, the exception being the North East where Type 106 rose by 18%. Other "non-epidemic" PCR ribotypes accounted for 28.9% of all isolates examined, an increase of approximately 7% on the previous survey (Figure 24). These mainly comprised types 002, 015, 014, 078, 020, 005 and 023. Of interest is the absence of Type 017, which constitutes the majority of toxin A negative, B positive ribotypes. Type 017 was present in four regions previously.

Figure 22: Changes in distribution of *C. difficile* PCR ribotypes between the two sampling periods (2005-6 and 2007-8)

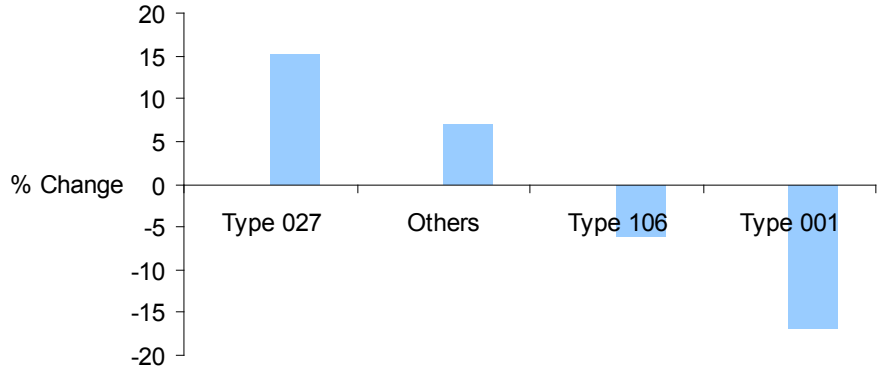


Figure 23: Changes in % distribution of PCR ribotypes by Region from 2005/6 to 2007/8

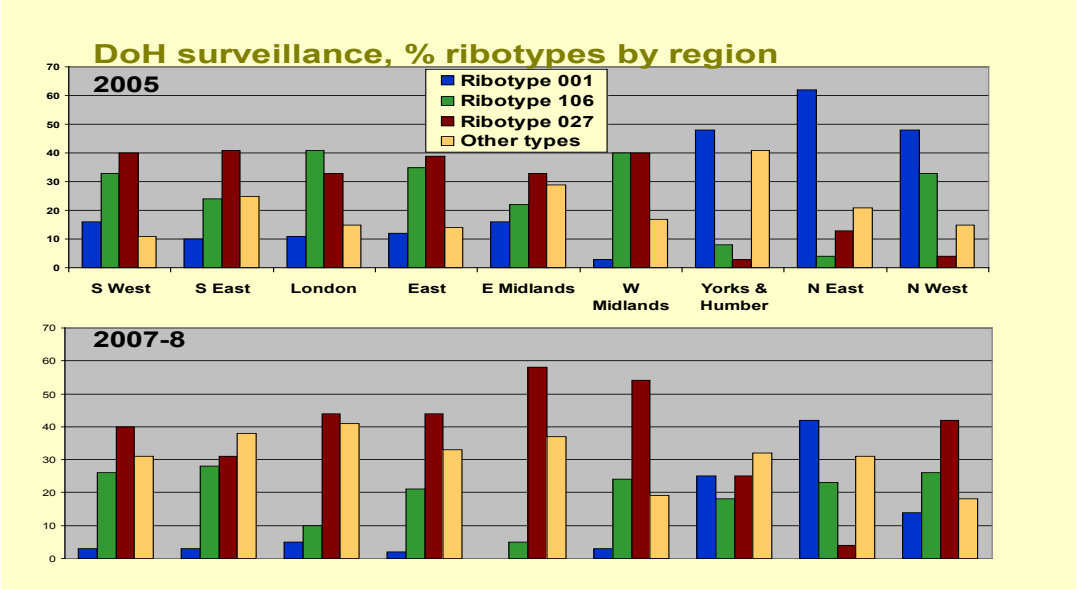
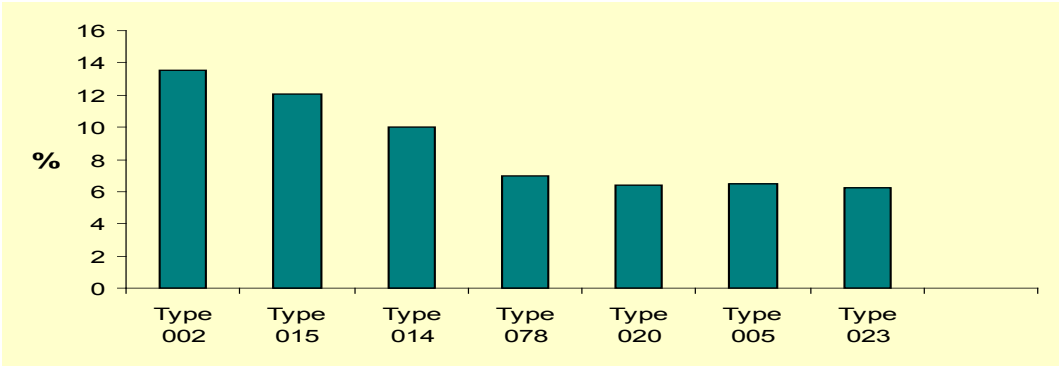


Figure 24: Distribution of the main "other" PCR ribotypes (28.9% of the total)



All the referred isolates (677) of *C. difficile* were tested for their susceptibility to a panel of eight antibiotics using the standard E test method. Importantly, resistance to metronidazole and vancomycin, the antibiotics of choice for treatment, was not detected.

Metronidazole: minimum inhibitory concentration (MIC) levels that might indicate clinical resistance to metronidazole were not detected. However, the MIC50 and MIC90 levels for metronidazole against the common PCR ribotypes 027, 106 and 001 were several dilutions higher, and their MIC ranges much larger, compared to the less common strains. Mean and median MIC values to metronidazole for the ten most common PCR ribotypes show a statistically significant difference between common (ribotypes 027, 106 and 001) and uncommon types (002, 005, 014, 015, 020, 023, 078). This suggests that metronidazole MICs are increasing in common *C. difficile* PCR ribotypes and should be closely monitored.

Vancomycin: there is no evidence of similar raised MICs to vancomycin amongst common ribotypes or non-epidemic ribotypes.

Erythromycin and *moxifloxacin*: common PCR ribotypes have much higher MICs to moxifloxacin and erythromycin than the less common strains which may indicate a selective advantage for resistance to these agents. Combined resistance to these agents is a good indicator of a common ribotype.

Imipenem: imipenem has little activity across all ribotypes, both common and uncommon.

Co-amoxyclav: Co-amoxyclav has a high degree of activity against all ribotypes, MIC range 0.094 – 3.0mg/L.

Pencillin and piperacillin-tazobactam: some resistance is evident, but does not appear related to type. MICs range from 0.38 to >32mg/L for penicillin and from 0.5 to 32mg/L for piperacillin-tazobactam.

2.2.7.2. Specimens referred for typing as part of local *C. difficile* investigations

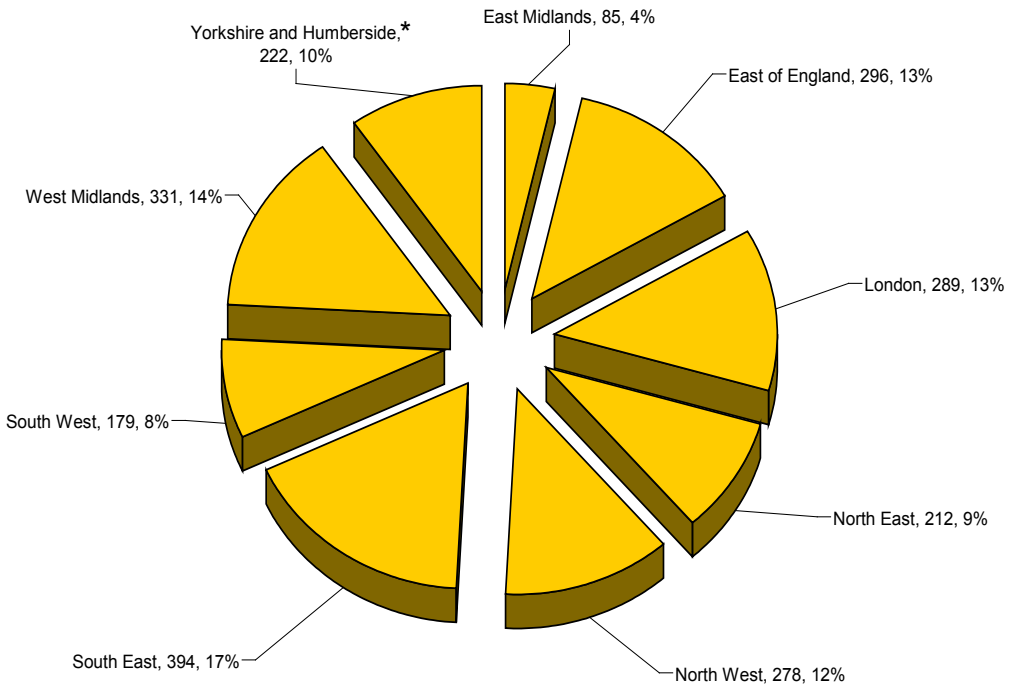
Trust laboratories are also asked to refer isolates for further investigation in the following circumstances:

- increased frequency of cases or high baseline rates of *Clostridium difficile* infection (CDI),
- increased severity/complications of cases of CDI,
- increased mortality associated with CDI, or
- increased recurrence rate of CDI.

This is undertaken through the *Clostridium difficile* Ribotyping Network for England (CDRNE) (see Appendix 2), established by the HPA in April 2007 to assist local teams to investigate *C. difficile* untoward events in order to better target activities to reduce the incidence of CDI. Further developments are planned for 2008, including web-based requesting and reporting and wider use of multilocus variable repeat analysis (MLVA) for investigation of specific ribotype clusters and high baseline CDI rates related to specific ribotypes.

A total of 2318 specimens were received by the CDRNE between April 2007 and March 2008 from 152 healthcare facilities (Figure 25), yielding 2169 *C. difficile* ribotype results (*C. difficile* recovery rate 93.6%).The most common reasons cited for sample submission were investigation of clusters of cases (46%), followed by severity of symptoms of CDI (13%) and unexplained increase in CDI rate (12%); 22% of requests did not provide information on the reason for referral. Men accounted for 34% of cases, 43% were women (23% of request forms failed record the sex of the patient). The age range was 2-103 years with a mean of 76 years and a median of 80 years.

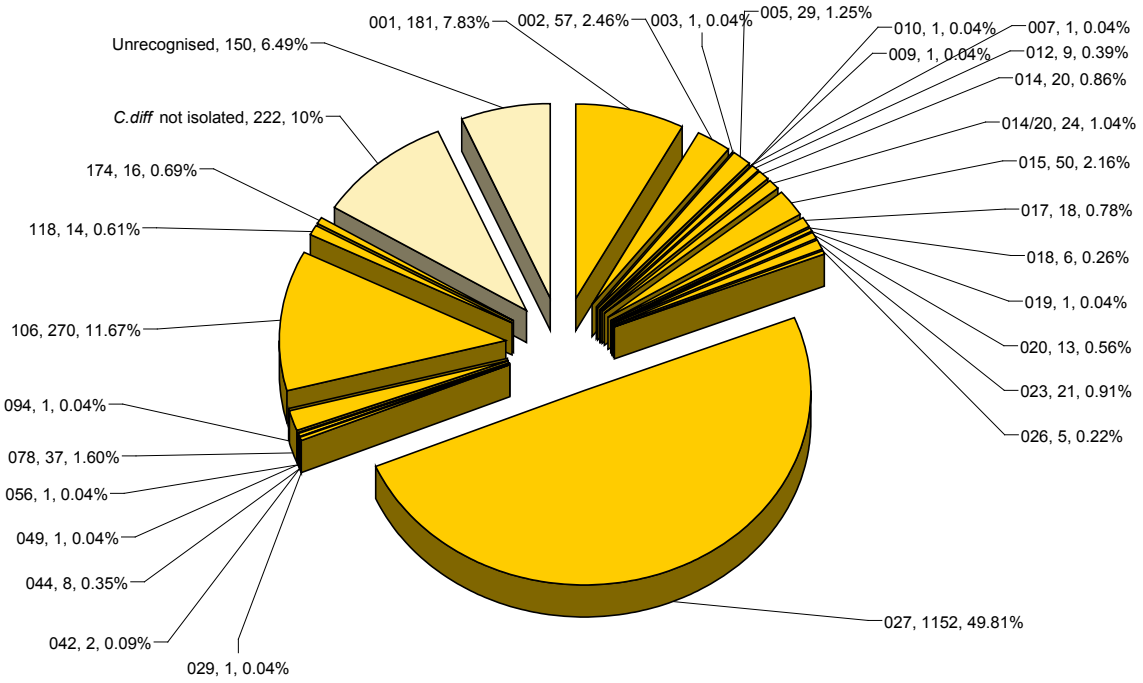
Figure 25: Specimens submitted to CDRNE in 2007-08 by region



* Ribotyping results for Leeds have been excluded from the 2007-08 CDRNE data as prospective surveillance during this time included ribotyping of all *C. difficile* toxin positive samples.

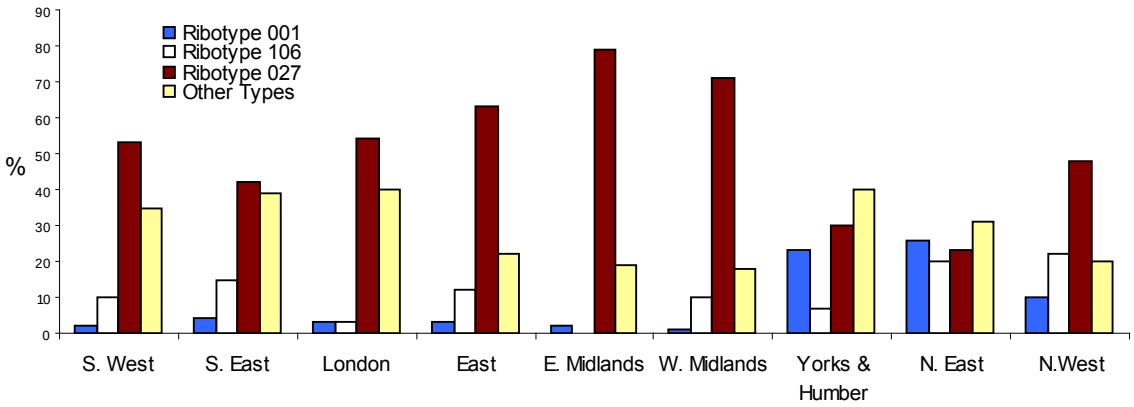
As also noted in the mandatory sampling scheme, the most commonly detected ribotypes overall were 027 (49.8%), 106 (11.7%) and 001 (7.8%)(Figure 26). There were marked inter-regional differences in the overall prevalences of the most common ribotypes (Figure 27), *C. difficile* ribotype 027 being the most common ribotype in all regions except the North East, where ribotype 001 (26%) was more prevalent than 027 (23%). In general, ribotype 027 was detected more frequently in the Midlands (72%) and less often in Yorkshire & Humberside (30%) and the North East (23%), while ribotypes 001 (17%) and 106 (21%) were more common in the North of England. The most common other ribotypes detected within a region were 174 in the S. West (7%), 015 in the East Midlands, (6%), 017 in Yorkshire (4%), and 002 (London, North East, North West, West Midlands; 2-6%). Inter-regional differences in ribotype prevalences may be influenced by reasons underlying sample referral to CDRNE (for example, outbreak investigation).

Figure 26: Distribution of ribotypes detected by CDRNE in 2007-08 (all regions)



The similarity of distribution of ribotypes between specimens referred for typing as part of the local CDI investigations (Figure 27) and the mandatory sampling programme (Figure 23) is quite striking. For the former, further information on cases is collected on the referral form on antibiotic use and clinical outcome. These analyses are undertaken on a national basis as the sample sizes within individual regions are relatively small, and there were marked differences between regions in response rates to questions on antibiotic use and outcomes. Care should be exercised with the interpretation of these results as data are incomplete.

Figure 27: Distribution of PCR ribotypes detected by CDRNE by Region 2007/08

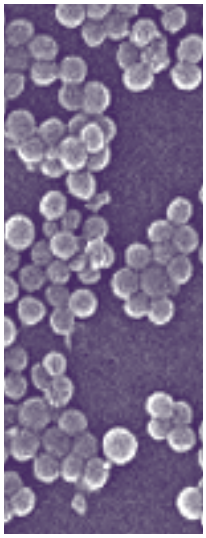


Although many request forms failed to mention recent antibiotic exposure, 44% indicated previous exposure to at least one antibiotic. Of those with information on recent antibiotic exposure, 66% and 30% listed use of more than one and three or more antibiotics, respectively. Such observations make interpretation of CDI risk associated with individual antibiotics extremely difficult.

Request forms that indicated the use of a specific antibiotic reported that cephalosporins (n=363), 'other antibiotic' (n=339), co-amoxiclav (n=312) and fluoroquinolones (n=260) were most frequently implicated. Of those cases where data were provided (n=917), 73% received metronidazole as treatment for CDI. Data analyses to determine whether specific antimicrobials are associated with particular *C. difficile* ribotypes have not been presented here because of concerns about potential reporting bias. It is anticipated that improving data capture in the future will reduce this potential bias.

Complete follow-up data were available for approximately 37% of cases. In those cases where data were provided, 4% (n=56), 6% (n=80) and/or 4% (n=38) had toxic megacolon, pseudomembranous colitis and/or surgical procedure(s) as a result of CDI. Although data are incomplete, only ribotypes 027 & 001 were significantly more frequently associated with all-cause mortality (OR:1.5/1.7;P=0.001/0.01), toxic megacolon (OR:1.8/1.6;P=0.01/0.01) and pseudomembranous colitis (OR:3.2/1.7; P= 0.001/0.009) than other ribotypes.

Request forms also enquired about admission to an intensive care unit (ICU) and deaths within 30 days of onset of infection to gauge severity and mortality. Data were incomplete, these questions not being answered in 40 – 50% of cases. Where information was available, there were indications that only a small proportion of infected patients required admission to ICU (c.3%) and that around 13% died within 30 days of onset of *C. difficile* infection (only 45% responded to this question), with *C. difficile* being considered a contributory factor in about one fifth of these. As noted previously these data are preliminary and incomplete and therefore need to be treated with caution.



3 Surveillance of Surgical Site Infections

3.1. Introduction

Surgical site infections (SSIs) are an important cause of healthcare-associated infections (HCAIs). They account for 14% of all HCAI, are associated with considerable morbidity and have been estimated to at least double the length of hospital stay[5]. There is evidence that the care provided before and after the operation, together with the skill of the surgeon, are critical in minimising the risk of SSI and that collecting and feeding back data on rates of SSI to the surgical team contribute to reductions in rates of infection[6,7].

The key aim of the SSI Surveillance service (SSISS) is to improve the quality of patient care by enabling hospitals to compare their rates of SSI over time and with other hospitals against a benchmark rate. Hospitals are able to choose to undertake surveillance in one or more of 13 categories of surgical procedure and since April 2004 have been required, as part of the mandatory surveillance programme, to undertake a minimum of 3 months surveillance in at least one orthopaedic category each year.

This section of the report presents an overview of all the SSI surveillance data collected in England in 2007 and aggregated five-year data submitted between January 2003 and December 2007. The analysis includes data from both NHS and independent sector hospitals that have participated in the surveillance. Three categories of surgical procedure have been excluded (bile duct & pancreas surgery, cholecystectomy and gastric surgery), because data for these categories are only available on a small number of operations.

The SSIs reported are based on infections detected during the hospital in-patient stay. Rates of SSI are expressed as either a cumulative incidence (the proportion of SSIs per 100 operations) or incidence density (the number of SSI per 1000 days of post-operative hospital stay). The incidence density takes some account of the length of post-operative stay in hospital, which varies between categories of surgical procedures. Developments are in progress to improve SSI surveillance by including surveillance in the period after discharge from hospital.

A more detailed review of the third year (April 2006 to March 2007) of mandatory surveillance of SSIs in orthopaedic surgery in NHS Trusts is available on the HPA website. The report on the fourth year will be available on the HPA website later this year.

3.2. Summary of SSI surveillance data

January to December 2007: 224 hospitals contributed data on 83 444 operations of which 898 SSIs were reported (Table 3). 88% of all operations were in the orthopaedic categories which form part of the mandatory surveillance programme. Rates of SSI ranged from 0.5 to 7.5 infections per 1000 post-operative days, with rates being highest in categories of surgery where the likelihood of microbial contamination at the surgical site is high e.g. small and large bowel surgery.

Since the surveillance of SSIs in orthopaedic surgery became mandatory in 2004, the number of participating hospitals has doubled in each of the four orthopaedic categories to a total of 73 000 in 2007. Hospital participation in the non-mandatory SSI surveillance has remained stable over the five year period at around 8500 to 9500 operations per year. This surpassed 10 000 in 2007, possibly heralding an expansion of non-mandatory surgical site infection surveillance by Trusts.

Table 3: Data contributed to the national SSISS, by category of surgical procedure – January to December 2007

Surgical category	Total no. hospitals	No. of procedures	No. SSI	Median length of stay (days)
Abdominal hysterectomy	12	1,031	4	4
Hip prosthesis*	166	31,182	171	6
Knee prosthesis*	160	31,667	97	5
ORLBF*	32	3,846	34	9
Hip hemiarthroplasty*	83	6,388	166	13
CABG	12	4,188	117	7
Vascular surgery	19	1,681	36	7
Limb amputation	11	612	39	15
Small bowel surgery	5	431	32	8
Large bowel surgery	20	2,418	202	9
Total	224	83, 444	898	

CABG=Coronary artery bypass graft; ORLBF=Open reduction of long bone fracture

* part of the mandatory surveillance programme

January 2003 and December 2007: 264 hospitals contributed data on 298 834 operations of which 5 012 SSIs were reported during the 5-year period (Table 4). Analyses over this longer period provide more robust estimates of the rates of SSI, as they are based on more data collected by a greater number of hospitals.

Table 4: Data contributed to the national SSISS, by category of surgical procedure - January 2003 to December 2007

Surgical category	Total no. hospitals	No. of procedures	No. SSI	Median length of stay (days)
Abdominal hysterectomy	42	5, 858	65	4
Hip prosthesis*	233	104, 960	995	6
Knee prosthesis*	217	103, 406	520	6
ORLBF*	50	14, 560	237	9
Hip hemiarthroplasty *	147	28, 277	992	14
CABG	18	21, 698	778	7
Vascular surgery	34	6, 656	228	8
Limb amputation	24	2, 336	195	17
Small bowel surgery	12	1, 676	173	9
Large bowel surgery	38	9, 407	829	9
Total	264	298, 834	5, 012	

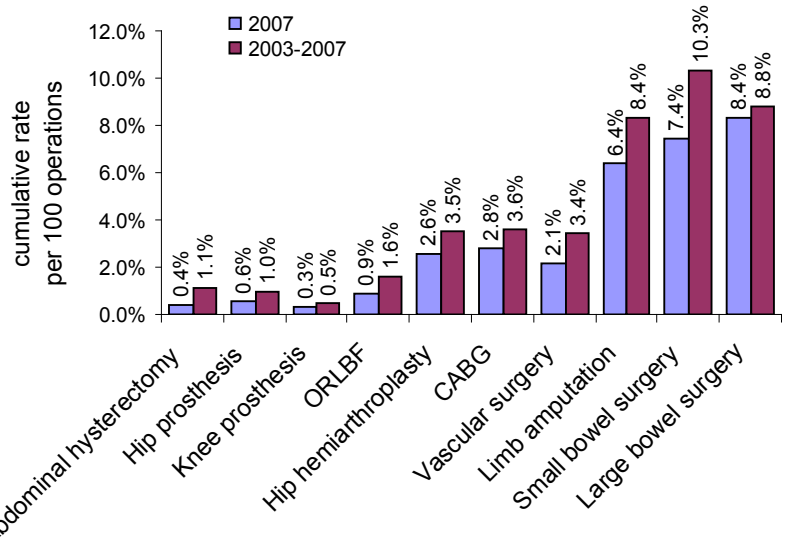
CABG: Coronary artery bypass graft; ORLBF: Open reduction of long bone fracture

* part of the mandatory surveillance programme

3.3. Cumulative incidence and incidence density rates by surgical category and time period

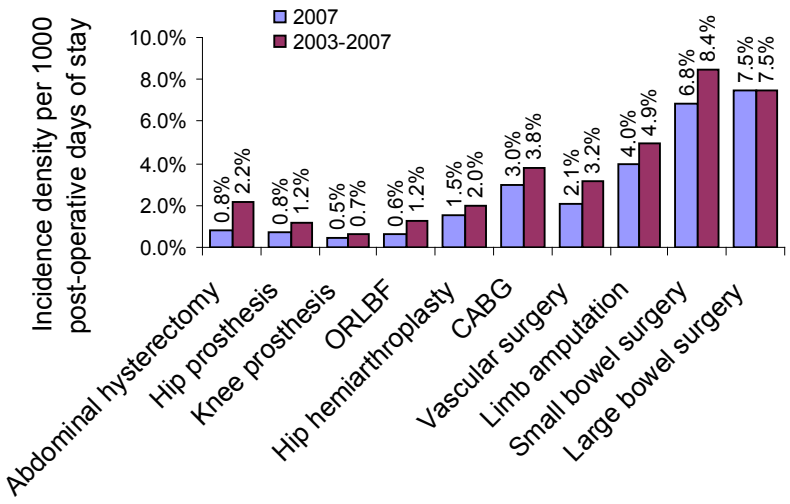
The cumulative incidence is the risk of SSI per 100 operations. The rates based on 5-year data ranged between 0.5% in knee prosthesis surgery to 10.3% in small bowel surgery (Figure 28). These rates are based on SSIs detected only during the inpatient stay.

Figure 28: Cumulative incidence (%SSI) by category of procedure



The SSI incidence density rates take into account the length of hospital stay. Based on data collected in 2007, the rates ranged from 0.5 to 7.5 infections per 1000 post-operative days. The SSI incidence rates based on 5-year data ranged from 0.7 to 8.4 infections per 1000 post-operative days (Figure 29). Rates were highest in categories of surgery where the likelihood of microbial contamination at the surgical site is high e.g. small and large bowel surgery.

Figure 29: Incidence density (per 1000 days of post operative stay)



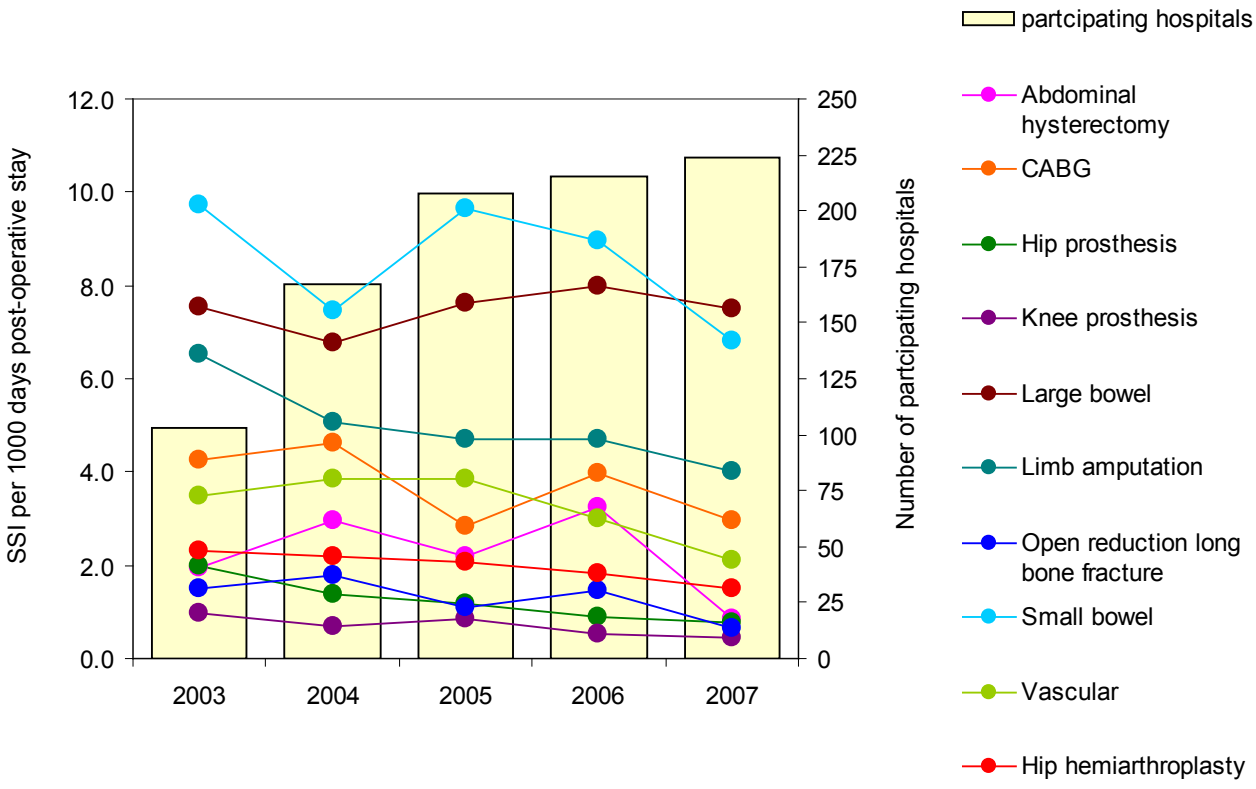
3.4. Five-year trends in incidence density of SSI by category of surgery

The yellow bars in Figure 30 represent the overall number of hospitals participating in surgical site infection surveillance by year. The introduction of mandatory surveillance in orthopaedic surgery in 2004 resulted in a significant increase in participation. Continued voluntary participation in non-mandatory categories reflects the extent to which hospitals value the benefits of the surveillance scheme.

For most categories of surgery, there has been a downward trend in the incidence density rate of SSI (Figure 30). However, these trends are difficult to interpret as they may be affected by fluctuations in the number of procedures (and hence precision of the estimated rate) or changes in the hospitals contributing data. There was no clear trend in abdominal hysterectomy, coronary artery bypass graft surgery, large bowel surgery and open reduction of long bone fracture, but these categories of surgery were particularly affected by fluctuations in the number of participating hospitals.

However, the risk of SSI has decreased significantly in hip prosthesis, knee prosthesis and hip hemiarthroplasty ($p < 0.04$) since the mandatory surveillance of SSI in orthopaedics commenced in April 2004.

Figure 30: Trends in incidence density of SSI and number of participating hospitals by year and surgical category.



CABG: Coronary artery bypass graft.

3.5. Risk factors for SSI

3.5.1. Risk Index

Data are also collected to enable a Risk Index score to be calculated for each operation. The Risk Index comprises three major risk factors for SSI: a) the severity of the patient's underlying illness b) the likely microbial contamination at the site of the incision and c) a prolonged operation. In procedures with a risk index of 0 none of these risk factors were present; if all three factors were present then the procedure had a risk index of 3. As expected, the risk of SSI (incidence density) increases with the number of risk factors present (Table 5).

Table 5: Incidence density (ID), per 1000 post-op days, of surgical site infection by risk index, January 2003 to December 2007*

	Risk Index 0		Risk Index 1		Risk Index 2 and 3	
Procedure	No. procedures	ID	No. procedures	ID	No. procedures	ID
Abdominal hysterectomy	4,053	1.79	696	3.81	68	5.04
CABG	407	2.44	12,865	3.49	1,419	5.25
Hip prosthesis	55,296	0.87	25,488	1.37	4,315	2.37
Knee prosthesis	57,685	0.5	23,246	0.9	2,449	1.32
Large bowel surgery	2,912	5.55	3,212	7.47	1,578	10.79
Limb amputation	162	3.13	690	3.64	828	5.84
Open reduction of long bone fracture	6,211	0.89	5,262	1.3	543	2.14
Small bowel surgery	217	8.04	630	5.95	463	10.57
Vascular surgery	1,181	1.9	2,772	3.22	1,444	4.4
Hip hemiarthroplasty	6,949	1.66	13,190	2	1,973	2.58

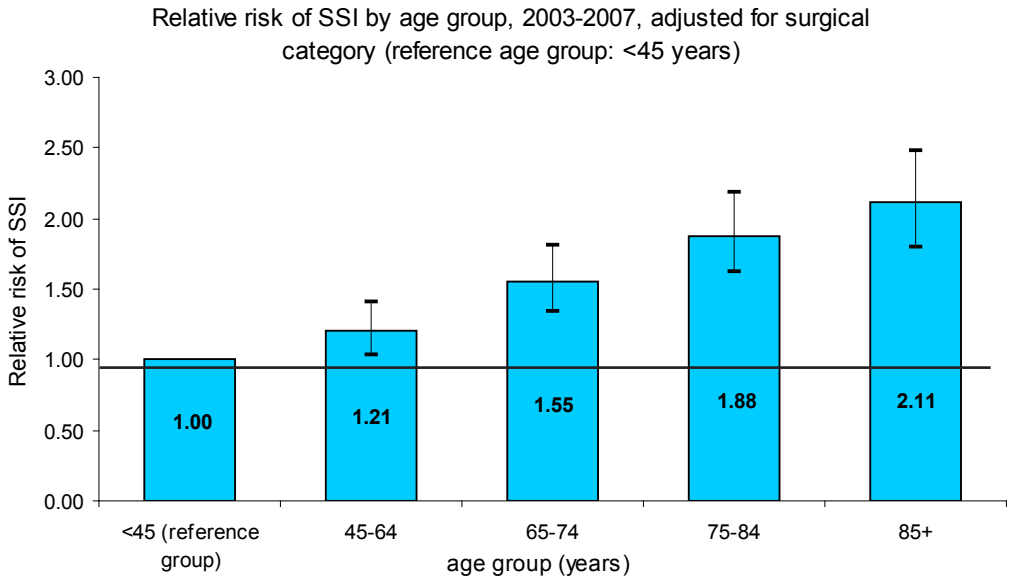
*Procedures with missing Risk Index data have not been included therefore the total number of procedures in each category may differ from those in Table 3 and Table 4.

3.5.2. The effect of age on the risk of SSI

The median age of patients for all categories combined is 71 years (ranging from 47.6 years for abdominal hysterectomy to 83.6 years for hip hemiarthroplasty). The high median age overall and the high median age in most of the individual surgical categories reflect the fact that the underlying age distribution of patients undergoing surgery is skewed to the left.

The risk of SSI increases with the age of the patient. Analysis of the five years data indicates patients aged 85 years or more, as a group, have twice the risk of developing SSI than patients in under-45 year age group (relative risk adjusted for surgical category = 2.1; $p<0.001$)(Figure 31). Further analysis indicated that there was a significant increase in SSI following surgery for each one year increase in age (estimated relative risk for a one year increase in age adjusted for type of surgery = 1.015718; $p<0.001$). For example, a 65 year old patient is estimated to have a 37% greater risk of developing a SSI than a 45 year old patient.

Figure 31: Relative risk of SSI by age group, data combined from January 2003 to December 2007*

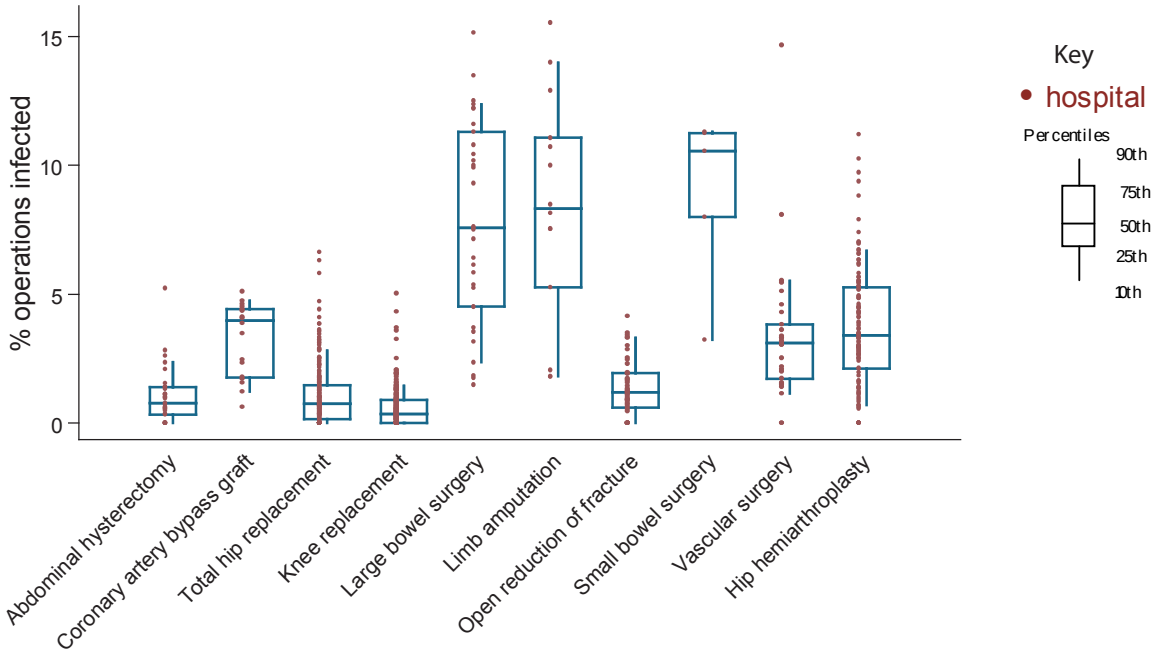


*Procedures with missing age data have not been included

3.5.3. Hospital variation in SSI rates

The rate of SSI within a category of surgical procedures varies considerably between hospitals (Figure 32). Some of this may be due to variation in risk factors in the patients undergoing surgery. Furthermore, when the rate is based on small numbers of procedures the estimate will be imprecise. Hospitals with rates above the 90th percentile are asked to investigate possible reasons for the high rate. Differences in the mix of patients and their underlying risks of developing SSI may contribute to variation in rates of SSI between hospitals.

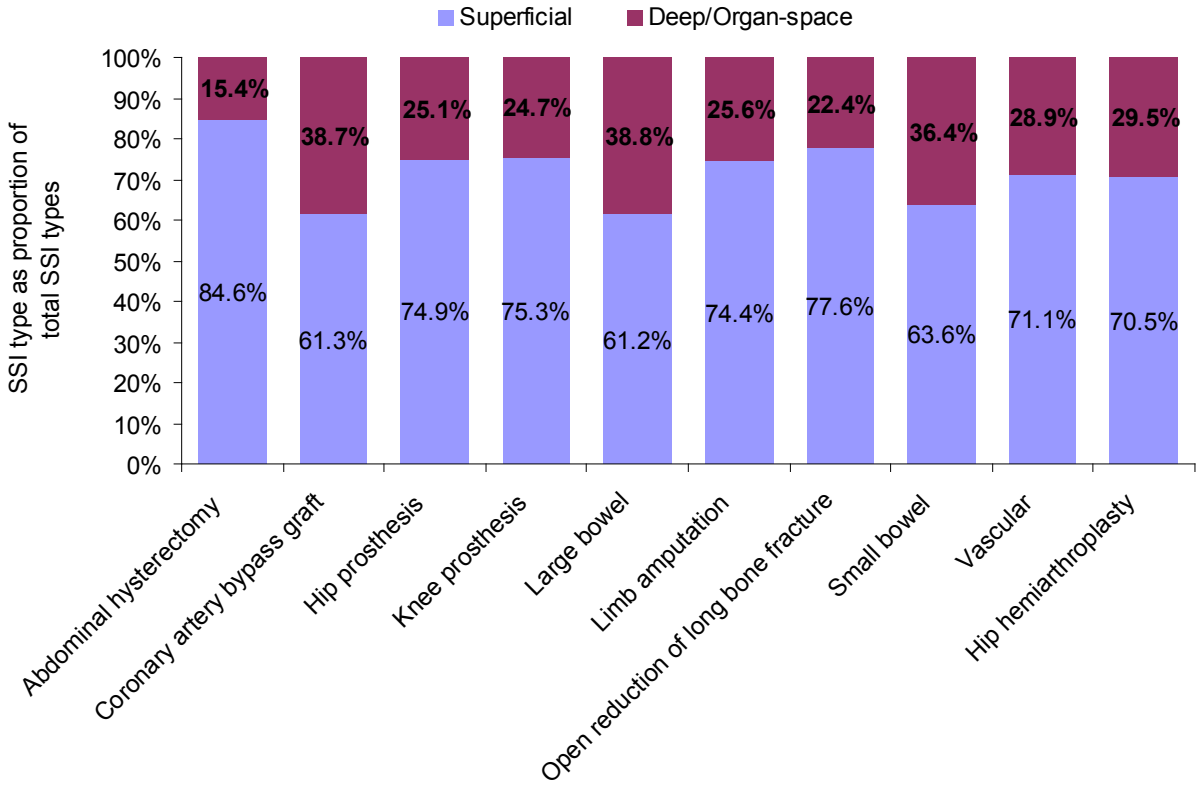
Figure 32: Variation in cumulative incidence rates of SSI between hospitals by category of surgical procedure. January 2003 to December 2007.



3.5.4. Type of SSI by category of procedure: January 2003 to December 2007

SSIs may affect only the superficial level of the surgical incision (skin and subcutaneous layers) or the deeper tissues (fascial and muscle layers, or part of the body that is opened or manipulated during the procedure). The latter are more serious and more difficult to treat. Figure 33 shows that the majority of reported infections are superficial, with approximately one third of SSIs affecting the deeper tissues.

Figure 33: Proportion of total SSIs involving superficial incisions or deep/organ-space – January 2003 to December 2007



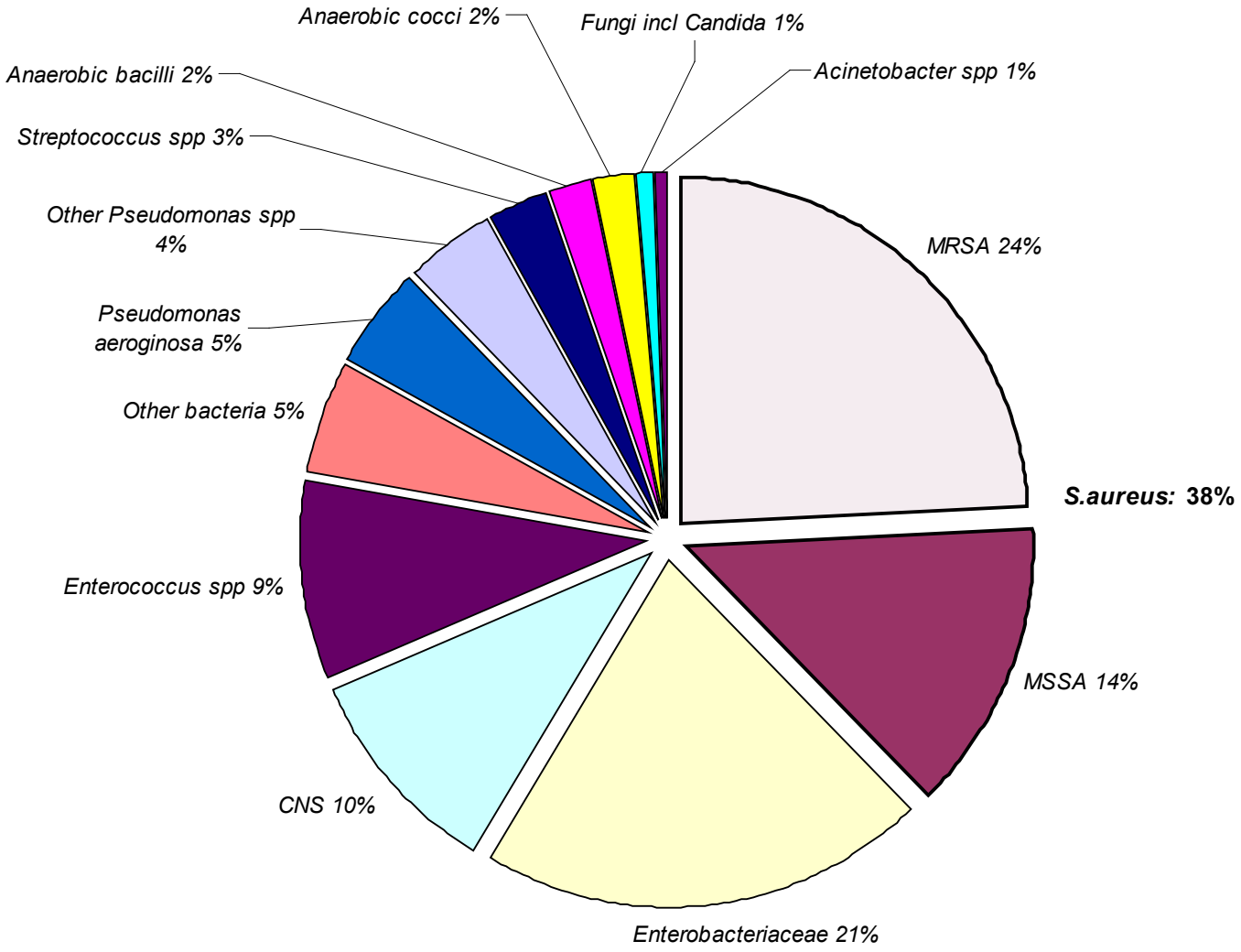
3.6. Micro-organisms reported as causing SSI

There were 5 012 SSIs detected during the 5 year period between January 2003 to December 2007 across all categories of surgery combined. At least one causative micro-organism was reported in 77% of SSI records (3 873/5 012). The most common causative micro-organism was *S. aureus*, accounting for 38% of all SSIs (Figure 34). Sixty-four percent of *S. aureus* infections were due to a meticillin-resistant strain (MRSA) (1246/1957). The proportion of SSI caused by *S. aureus* was highest in hip hemiarthroplasty (57%), followed by limb amputation (54%) and open reduction of long bone fracture (52%).

Enterobacteriaceae caused the second largest group of infections, accounting for 21% of all SSIs. These were a prominent cause of SSIs in three categories: large bowel surgery (33%), coronary artery bypass graft (32%), and small bowel surgery (30%).

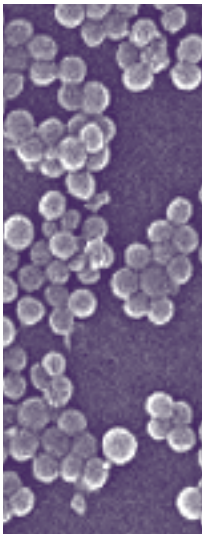
Although the data showed evidence of a significant reduction in the risk of SSI for all categories combined over the 5 year period ($p<0.001$), there was no change in the proportion of *S.aureus* infections that were due to MRSA over the same time period ($p=0.327$).

Figure 34: Distribution of causative micro-organisms - all surgical categories. January 2003 - December 2007.



Note:
CNS=coagulase negative staphylococci
MSSA=meticillin-sensitive *S.aureus*
MRSA=meticillin-resistant *S.aureus*

Total number of organisms reported = 5,178



4

HCAI: Beyond Surveillance

The focus of this Annual Report is on the surveillance of HCAI. However, this chapter illustrates some examples of other work being undertaken in the Health Protection Agency at local, regional, national and international level, concentrating in particular on some of the initiatives undertaken by the Local and Regional Services Division. The following is a small example of the work carried out by different parts of the HPA in HCAI.

North East HPA

The North East HPA has been involved in a multi-agency response to develop a standardised approach to managing diarrhoea and vomiting outbreaks in care homes and the production of a resource pack as there were significant variations in roles and responsibilities, processes and information requirements in care homes for such events.

To address this a multi-agency group was established in Northumberland, Tyne and Wear, which brought together representatives from the health protection team, eight local authorities, three primary care organisations, the Commission for Social Care Inspection, Northumberland, Tyne and Wear NHS Trust and the HPA laboratory in Newcastle.

The principal objective was to develop an agreed evidence-based protocol. The group agreed roles and responsibilities for managing an outbreak of diarrhoea and vomiting in care homes and revised and updated the guidelines, infection control advice and surveillance tools. As a result, a resource pack that will be available in each care home has been developed. It contains a simple flow chart to guide homes through the protocol, plus information on relevant roles and responsibilities, advice on infection control and specimen collection and storage, stool specimen collection kits plus an outbreak notification poster. Allied to this, there is an agreement with the HPA laboratory in Newcastle about how specimens from outbreaks in care homes are processed and results reported. This standardised approach will be adopted across all of the North East region.

East Midlands HPA

From 2006 to 2007 hospitals in Leicestershire experienced an increase in the number of patients with *C. difficile* infections. As a result, a programme to reduce the numbers of infections was established. As part of this approach, an isolation ward was opened in one hospital whilst antimicrobial prescribing was reviewed and deep cleaning and hand hygiene campaigns were implemented in all hospitals.

The HPA worked with Leicestershire Primary Care Trust to produce clear antimicrobial guidelines for use in Primary Care to reduce the use of certain antibiotics, such as cephalosporins, and to ensure consistency with antimicrobial guidelines in acute care. Simple treatment algorithms for the management of patients with *C. difficile* in community settings were also developed and training sessions were held for GPs to familiarise them with the guidance.

A concern that nursing and residential care home residents could be bringing *C. difficile* into hospitals was addressed through an audit undertaken by the HPA of all admissions to one medical unit who were found to have *C. difficile* either on or after admission during a two week period. This showed that being a resident in a nursing or residential care home was not a risk factor for having *C. difficile*. It also showed that patients who had *C. difficile* on admission had previously been in hospital in the last 3 months.

The audit also revealed lack of clarity in clinical records or discharge letters of the reason for prescribing proton pump inhibitors, which are used to heal stomach and duodenal ulcers. These agents have an effect on the lining of the gut and may render patients more vulnerable to infections like *C. difficile*. This finding led to a major review of the use of proton pump inhibitors locally.

North West HPA

Infection prevention and control is the responsibility of every healthcare employee, whatever their role, wherever their location. Ensuring that people receive appropriate and regular education and training to maintain evidence based practice is fundamental to the safe working practices of each member of staff.

However, discussion between staff at the three HPUs in the North West and the regional training lead for Commission for Social Care Inspection (CSCI) identified a gap in the provision of training for some staff employed in care home facilities, a particular problem being difficulty releasing members of staff in care facilities to attend training events.

In response to this, nurses at the three HPUs devised a Training Resource Pack for care homes. The pack included infection control power point presentations, an audit tool, teaching aids and an evaluation tool. It enables a designated member of staff in the home to deliver the programme and audit infection control procedures within the care setting in a consistent way across the region.

Each HPU then arranged, in collaboration with CSCI, local Environmental Health Officers and Community Infection Control Nurses, a series of training events in their own locality. The training was first provided for members of staff at CSCI to update them on infection control and prevention and to familiarise them with the pack. Training was then provided for senior staff within the nursing homes so that they could facilitate and tailor internal training appropriate to the needs of their staff.

The pack was launched at the Northwest Annual Public Health Conference in 2006. The Training Resource Pack[8] is a CD Rom and is available via application on the NW HPA website for a nominal fee.

East of England Group

NHS East of England released a consultation document 'Improving Lives; Saving Lives' in autumn 2007, which set out a vision of making the East of England the best health service in England. It provided an objective against which performance can be judged and a series of 12 pledges. Pledge six states that the Region will aim to make the healthcare system in the East the safest in England. Reducing HCAI is seen as a key part of this pledge.

A cross-agency HCAI Task Group was established at regional level to influence practice and support a programme of action to reduce HCAI. This complements the East of England HCAI Intensive Support Team, set up in early 2007, to work with acute Trusts to reduce the incidence of *C. difficile*. HPA staff have been involved in the Task Group in a number of ways, such as providing and interpreting HCAI data, as well as advice on laboratory testing and clinical or infection control issues. Results have been encouraging, in particular with continuing reductions in *C. difficile* infection. Compared to the previous year there was a 30% reduction in reported cases in 2007/08 patients aged 65 years and over.

Laboratory of Healthcare-Associated Infection: Acinetobacter typing

Acinetobacter baumannii is an important nosocomial pathogen which causes opportunistic infection, primarily in intensive care patients and those with severe burns. The hallmarks of the species are its ability to acquire resistance to antimicrobials and persist in the hospital environment. Generally the disease burden is low and most isolations represent colonisation of airways, line tip sites and occasionally the urinary tract. However, severe sepsis may occur. Outbreaks tend to be protracted and difficult to control.

In recent years it has become clear that most clinical isolates of *A. baumannii* belong to a relatively small number of genetic lineages, most of which are closely related to one another. Two clones, known as the South East clone and OXA-23 clone 1, have become widespread in the UK, particularly in the South East, and exhibit resistance to almost all available antibiotics with the exception of polymyxin, and perhaps tigecycline. These clones were identified by pulsed-field gel electrophoresis (PFGE) of ApaI digested genomic DNA. Sequence based typing showed that outbreak strains fall into three highly distinct clonal groups, corresponding to European clones I, II and III, with all the most prevalent UK genotypes, and the T-strain, belonging to European clone II. The finding of representatives of each of these clonal lineages in multiple countries with no apparent epidemiological links between them, and with distinct PFGE types, suggests that they have been independently selected from common ancestors that are widespread.

The Laboratory of Healthcare Associated Infection has identified two variable number tandem repeats (VNTR) targets. This is valuable as it provides a way of 'fine-typing' within widespread genotypes. The repeat numbers of representatives of each genotype often differ between hospitals, providing a means of tracking patient transfers and possible transmission of infection. As a result of using this technique, it is becoming clear that outbreaks in some hospitals are caused by more than one strain of *A. baumannii.*

CfI: International collaborations

There are numerous international collaborations, particularly with other European countries. These relate to:

- participation in and development of surveillance systems in the HELICS* and EARSS** networks (Improving Patient Safety in Europe (IPSE) Work Packages).

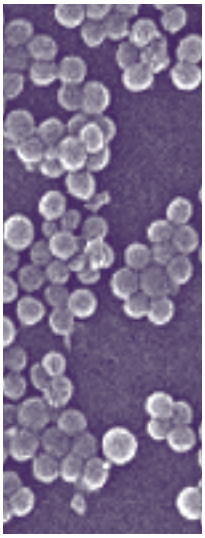
- assessment of the current stage of development of individual countries in infection control, such as "Antimicrobial Resistance in Mediterranean Countries"[9] which showed that progress in development of infection control on a national level varied significantly throughout the region

- development of guidelines and programmes, (for instance in the first Global Patient Safety Alliance Challenge (Hand Hygiene), the most successful WHO campaign in numbers of countries participating and

- development of infection control indicators for ECDC and WHO and the competencies required for infection control professionals (in "Improving Patient Safety in Europe (IPSE)", a DG SANCO project.

*HELICS - Hospital in Europe Link for Infection Control through Surveillance – a European network for surveillance of healthcare-associated infections.

**EARRS - European Antimicrobial Resistance Surveillance System.



5 Key issues for the future

Much has already been done in terms of improving the quality of patient care and patient safety by focussing attention on some significant causes of HCAI, such as *C. difficile* and MRSA infections. Surveillance has been a key component of the activities to drive down rates of HCAI, not only by providing local information on potential problems and allowing benchmarking against rates elsewhere, but by becoming intimately allied to the performance management process through the setting of national targets. This has been a relatively recent development and one which has had a dramatic effect in reversing MRSA bloodstream infection trends. However, this raises two particular issues: (i) the extent to which these intense activities are sustainable in the longer term and (ii) how the focus of activity can be extended to reflect the broader public health impact of HCAI, which varies according to the infection and the pathogen, and the relative contribution from hospital and community-based healthcare. This section will focus on the second issue, highlighting outstanding aspects of HCAI surveillance warranting further attention. This is largely based on the work of the Steering Group on HCAI (SG-HCAI), which considered these matters at length as detailed in SG-HCAI Final Report[3], as well as HPA expertise in this field and findings from other sources, such as the Hospital Infection Society/ Infection Control Nurses Association prevalence survey in 2006 which identified common HCAI in the UK and Republic of Ireland.

Distillation of information from these various sources demonstrates that priority areas for further action include:

• surveillance of infections in special units, such as critical care, renal and haematology/oncology units where patients are especially vulnerable to infection through either their underlying disease or its treatment and, additionally, are exposed to many hazards through indwelling devices, instrumentation etc... Infections in these areas account for a significant proportion of HCAI and are associated with high morbidity and mortality. Treatment of these infections results in heavy antimicrobial use, often of valuable third line 'reserve' agents. Furthermore, these units are key loci for device-related infections and are frequently the focus within a hospital of emerging HCAI pathogens such as *Acinetobacter baumannii*, glycopeptide-resistant enterococci (GRE), *Candida* spp, coagulase negative staphylococci and multi-resistant gram negative rods.

• improved reporting of outbreaks and untoward events (including unusual antimicrobial susceptibility), allied with enhanced collaboration in the investigation of these events.

• surveillance of surgical site infection after discharge from hospital as well as broadening the focus of mandatory surgical site infection surveillance to other types of surgery where the risks of SSI are higher, for instance, through a rolling programme covering a wider selection of surgical categories.

• establishing routine monitoring of case fatality rates in patients with HCAI, notably *C. difficile* in the first instance, building on methods pioneered in the joint ONS and HPA confidential study of the mortality associated with MRSA infection which addressed the limitations of using death certificates alone to monitor mortality associated with HCAI[10].

• improving the surveillance of the pathogens causing common infections such as urinary tract infections (UTIs) through the automatic capture of antimicrobial data from hospital laboratory systems across the country, coupled with automated susceptibility testing in sentinel laboratories.

• developments to the current mandatory system for *S. aureus* surveillance to improve our knowledge of (i) MRSA risk factors by including existing root cause analysis information, (ii) the extent to which MRSA bloodstream infections acquired prior to admission are hospital or community-related, (iii) consideration of collation of data from the admission screening programme to improve the knowledge of the total burden of MRSA in acute Trusts, shifting the focus away from the severe end of the spectrum of infection; and (iv) MSSA bloodstream infections.

• improving surveillance of PVL-positive *S. aureus* to ensure there is early warning of whether this country is facing a similar

situation as that described in North America (see below).

• enhancements to the existing mandatory system for *C. difficile* to identify whether the epidemiology of *C. difficile* is changing, particularly as regards community-acquisition and risk factors.

• surveillance of antimicrobial prescribing in hospitals, in order to assess how closely prescribing is linked to emergent resistance and to improve prescribing through benchmarking.

• external validation of the reported data, for instance as part of the Healthcare Commission's inspection programme.

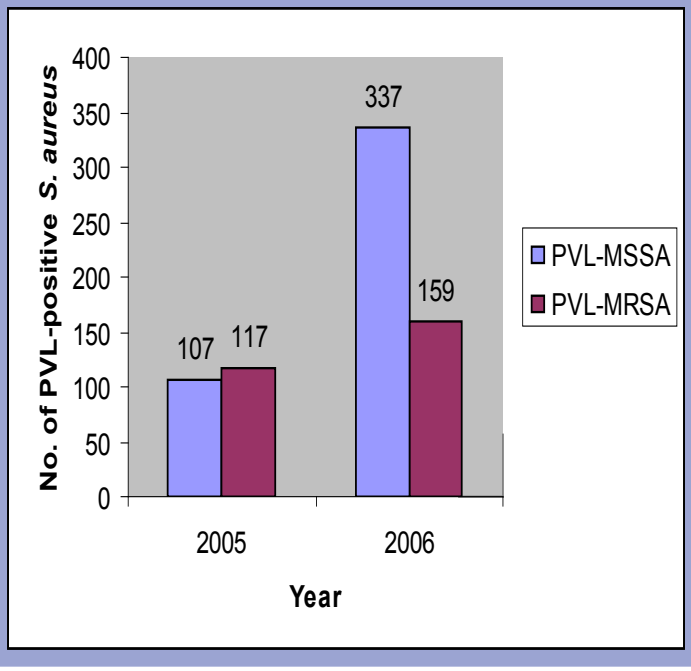
At first sight this list may appear overly long in terms of priorities for action, but few require the development of totally new systems. This would be required for surveillance in special units and of hospital antimicrobial prescribing. However, in most instances, the changes require either improvements to existing systems (for instance, developments to improve *S. aureus* and *C. difficile* surveillance), or the developments are underway or imminent. Examples of the latter include the developments in progress to support outbreak reporting, post-discharge surveillance of surgical site infection and automatic downloading of hospital laboratory data to provide antimicrobial susceptibility information. In other instances the methods have already been established, for instance, tools for monitoring case fatality, or a change in emphasis is required within an existing system, such as creating a rolling programme for surgical site infection surveillance rather than focussing on orthopaedics. Furthermore, addressing a few issues robustly, such as establishing surveillance in special units, would have a much broader impact in terms of identifying emerging problem pathogens or multi-resistance.

A special case for vigilance: PVL-producing *S. aureus*

Panton-Valentine Leukocidin (PVL) is a toxic substance produced by some strains of *Staphylococcus aureus.* PVL-production has been strongly associated epidemiologically with virulent, transmissible strains of *S. aureus* (both MSSA and Community-Associated MRSA, CA-MRSA). There is nothing new about PVL-producing strains of *S. aureus* (PVL-SA): the 'phage type 80/81 strain which caused widespread disease in healthy people in the community, hospitalised patients and healthcare workers in the 1950s and 1960s was PVL-MSSA. The escalation in morbidity and mortality associated with certain strains of PVL-SA in some countries, such as the United States, has caused public health concern world-wide.

National surveillance of PVL-SA is currently based on isolates referred to the Reference Laboratory for further investigation. In the light of the evolving situation in other countries, there have been national alerts and improved case ascertainment initiatives to raise the awareness of PVL-SA and ensure specimens are sent for appropriate testing. During 2005 and 2006, a total of 720 cases of PVL-SA were identified from specimens referred to the Reference Laboratory (Figure 35).

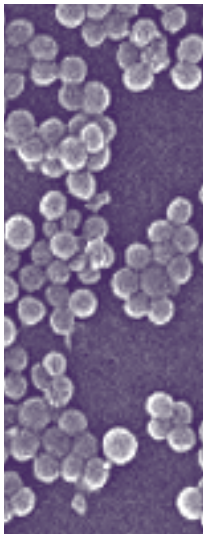
Figure 35: Number of PVL-SA identified by HPA in England and Wales during 2005-6.



A small (0.4-fold) increase in the number of PVL-MRSA occurring nationally between 2005 and 2006 was noted, with a three-fold increase in the number of PVL-MSSA over the same timeframe. At this juncture, it is not clear whether the increasing numbers observed between 2005 and 2006 reflect improved case ascertainment as a result of the awareness-raising initiatives and/or an increasing prevalence of PVL-SA. It is anticipated that a DH-funded study to obtain more robust data on the current situation will start in 2008.

The majority of infections have been associated with PVL-MSSA. Most PVL-SA have been sporadic in occurrence and associated with relatively mild skin and soft tissue infections. Sporadic cases were identified among individuals known to belong to recognised risk groups (e.g. residents in long-term care facilities, military personnel, participants in close contact sporting activities, prison inmates, injecting drug users and men who have sex with men). Occasional clusters of disease were identified among individuals in close contact (e.g. households or schools). Two PVL-MRSA outbreaks in healthcare settings were documented during 2007, one involving a neonatal unit and the other a burns unit.

Local and regional staff continue to be actively involved in contact tracing and offering advice on infection control and prevention of PVL-SA, supported by experts from the Agency's Centre for Infections in London. Interim guidance on the diagnosis and management of PVL-SA infections was prepared by the HPA in 2006. This has been expanded and updated by a sub-group of the Steering Group on HCAI and is due for publication shortly.



Appendices

Appendix 1.

What is HCAI?

Healthcare-associated infection is an infection that results from exposure to health care. In the past this was most frequently associated with treatment in hospital and so was usually called 'hospital-acquired infection' (HAI). However, health care is increasingly occurring outside hospitals, for instance in nursing homes, primary care and even in the patient's home. Consequently health care procedures undertaken in non-hospital settings may also result in infection, hence the broader term 'healthcare-associated'.

Typically healthcare-associated infections result from a complex interplay between the micro-organism, the patient and the environment, where factors such as the virulence or transmissibility of the micro-organism, the vulnerability of the patient (immuno-compromised, diabetic etc) and infection hazards associated with the environment they are in (surgery, intensive care etc) come into play. Not all such interactions result in infection – sometimes carriage of the micro-organism without it causing any harm results.

The micro-organisms involved in these interactions normally come from either the patient themselves (endogenous infection) or other patients or staff (cross-infection), with spread occurring by contact (hands, clothing, equipment, the environment etc) or airborne routes (respiratory droplets or skin scales).

Are all HCAI preventable?

Given the complexity of the interactions described above, almost any procedure can result in an infection, though some are riskier than others. The causative micro-organisms are varied. Procedures which may be life-saving, such as artificial ventilation of a seriously injured patient in the Intensive Care Unit or treatment for leukaemia, may render a patient more vulnerable to infection by making breaches in their normal defence system against infection. Consequently all HCAI cannot be eliminated, but the aim of infection control is to reduce these infections to the minimum.

Caveats

As with all surveillance, the caveats are important and affect interpretation of the data. Direct Trust comparisons are tempting, but there may be differences between Trusts in the types of patients treated and the spectrum of clinical activity which mean that they are not directly comparable. Consequently caution should be exercised in interpreting the results and outlying rates should be subject to further investigation to assess whether they reflect differences in case-mix or actual performance.

Appendix 2.

Sources of information

Bloodstream infections -Voluntary surveillance data

Microbiology laboratories in many hospitals in England have contributed data on micro-organisms causing significant clinical infections to the HPA, and previously the Public Health Laboratory Service, over many years. Data on micro-organisms causing bloodstream infections are particularly rich and are valuable for showing trends of infection over a long period. Data for bacterial and fungal bloodstream infections voluntarily reported by participating laboratories in England for the years 2003 to 2007 were extracted from the HPA's database for these reports (LabBase2). LabBase2 data are indexed with a unique identifier known as "Organism Patient Illness Episodes", also known as "OPIEs". Each OPIE refers to a single patient episode (usually 14 days) and holds data for a single organism. If a patient has had two different organisms isolated from a blood culture during a single illness episode, each organism isolate will be assigned a unique OPIE identification. As it is not uncommon for two or more different organisms (including either bacteria or fungi) to be isolated from a single blood culture, estimating the number of reported patient blood infections requires identifying those OPIEs that relate to a single patient episode, thereby ensuring patient infection episodes are counted just once. Prior to analyses, the number of patient episodes are identified by matching records based on the following fields: specimen date, laboratory, patient date of birth, gender, and soundex (alphanumeric coding of the patient's surname). All records for which these variables are identical (and not null) are defined as being a single patient episode and are counted just once in the patient bloodstream infection analyses. An infection episode is defined as fourteen days – additional patient laboratory reports dated within fourteen days of the original are removed from analyses (often referred to as "de-duplication"). Rates of infection per population were calculated using resident population estimates for the respective years. Unfortunately, identifying bloodstream infections is potentially complicated by contamination during either drawing of blood from the patient or during the culturing/identification in the microbiology laboratory. While the HPA requests that participating laboratories only report clinically significant specimens, there is the possibility that results from contaminated specimens are also sometimes reported.

Bloodstream infections - Mandatory blood culture and *Staphylococcus aureus* surveillance

Since April 2001, the HPA has undertaken mandatory surveillance in England of the total number of blood cultures as well as those testing positive for the presence of at least one micro-organism. Under this scheme, all Trust laboratories in England are required to report to the HPA the aggregate numbers per quarter for their respective laboratories. Mandatory surveillance also includes reports of *S. aureus* isolated from blood cultures in English acute Trusts. These data are used to monitor trends in MRSA bloodstream infection. Each of England's NHS acute Trusts contributed to the mandatory surveillance scheme for *S. aureus* in the period from April 2001 to March 2008. Data were collected quarterly from each acute NHS Trust in England by HPA Local and Regional Services Division (LaRS) and transferred to the HPA's Centre for Infections (CfI) for national analysis. The DH Healthcare Associated Infection Surveillance Steering Group was responsible for developing the original dataset for this mandatory surveillance scheme, which has undergone evolution since then. Methodological and interpretative information, including a glossary of terms, is published elsewhere. All analyses were performed according to the current configuration of Trusts. Data from merged Trusts were combined for pre-merger time periods. Regional analysis was performed using the HPA English regional boundaries introduced in April 2002. Patient bed-day data for the financial year April 2007 to March 2008 were not available at publication, so data for April 2006 to March 2007 were used for the analysis of MRSA rates per bed-days, using MRSA bloodstream infection data corresponding to April 2007 to March 2008.

Bloodstream infections - Rates of MRSA

Trends for both HPA region and Trust type have been analysed by rate. The rates for individual regions and Trust type have been calculated on the basis of hospital activity. This uses the data on bed occupancy which individual Trusts send to the Department of Health annually. These bed occupancy figures are from the KH03 national dataset, which forms part of the Korner health statistics. A Trust's activity is measured by assessing bed occupancy daily at midnight (the figures only apply to overnight admissions, so day cases are excluded) and this is then used to calculate average daily bed occupancy. Figures for the NHS Acute Trusts have been used to derive an MRSA rate for the individual regions per 10 000 occupied bed days. Specialty rates have been determined.

using Hospital Episode Statistics (HES) data for the period 2005/6 and 2006/7.

$$\text{Trust Rate calculatio n} = \left[\frac{\text{Number of MRSA bacteraemi a reports from that Trust for the time period}}{\text{Average daily bed occupancy} \times \text{Number of days in the time period}} \right] \times 10{,}000$$

Bloodstream infections -Study of MRSA bloodstream infections in children

Cases were identified and data collected from a combination of sources, comprising questionnaires filled in by paediatricians as part of the BPSU monthly orange card reporting system, microbiology reports from hospital laboratories and bacterial isolates sent to national Reference Laboratories. Data from these sources were then pooled and reconciled. Isolates of MRSA from children were characterised in terms of their antibiotic resistance pattern, strain type and biological properties, particularly virulence traits. Possible associations between organism type and clinical features of infection were investigated.

Bloodstream infections - Mandatory GRE bloodstream infection surveillance

As part of the mandatory surveillance of glycopeptide resistant enterococcal bloodstream infection, each acute NHS Trust in England submits these data quarterly to the Health Protection Agency Local and Regional Services Division (LaRS), which are then collated and analysed by the Centre for Infections. The National Glycopeptide-Resistant Enterococcal Bacteraemia Surveillance Working Group recommended that the significance of blood cultures containing GRE should be assessed clinically. If a blood-stream infection is found to be clinically significant and due to either a GRE or a GRE and other non-GRE organism(s), it should be reported as a GRE bloodstream infection. Trusts are asked to report all GRE bloodstream infection cases they have detected, whether or not they were considered to be acquired in their Trust, in another hospital or in the community. Positive blood cultures from the same patient within 14 days of the initial culture are considered to be part of the original episode and should not be reported. Duplicate reports, more than 14 days apart should be reported as these are considered to be a separate episode. Enterococci from blood cultures should be tested for susceptibility to the antibiotic vancomycin. Teicoplanin is not an acceptable alternative to vancomycin for these purposes.

Gastrointestinal infections - *C. difficile surveillance*

The HPA also operates two major surveillance schemes for *Clostridium difficile* in England, a voluntary and mandatory scheme. The voluntary surveillance system monitors a range of infectious diseases, including *C. difficile* and has operated since 1990. Reports are made via the HPA's microbiology reporting database ("LabBase2"). Ascertainment on the voluntary system has been improving, with a steady rise in the number of laboratories reporting to LabBase2 since 1990.

In order to improve the accuracy and completeness of reporting, mandatory surveillance of *C. difficile* was introduced in 2004 for patients aged 65 years and over. Unlike the voluntary reporting system, all English NHS Acute Trusts partake in this scheme. This scheme collects aggregate data by Trust on the number of toxin-positive *C. difficile* specimens from patients aged 65 years and over. Most *C. difficile* infections occur in this age group, although cases of *C. difficile* infection have been reported in all ages. Infants and neonates may test positive for *C. difficile* toxins, but this is usually not clinically significant. Consequently this age group is not included in mandatory surveillance. Enhancements to the mandatory surveillance scheme for *C. difficile* in those aged 2 years and over were introduced in April 2007 to enable more targeted action to reduce infections. The enhanced scheme operates as a real time web-enabled reporting system that collects data on individual patients, such as date of birth, sex, location at the time when specimen taken, and the provenance of the patient. During the last year (April 2007-March 2008) the enhanced surveillance dataset collected for *C. difficile* infection has been further refined to include more patient and care information. More recently, NHS number has become a mandatory field; this represents the first step in linking data to other national data sources to improve data quality.

Rates of *C. difficile*

Bed days were calculated using Hospital Episode Statistics (HES) data for the stated period. For each episode within a trust where the patient's age at the start of the episode was 65 or more years, the episode start date was subtracted from the episode end date to produce an episode length in days. These were then totalled over the trust.

$$\text{Trust Rate} = \left[\frac{\text{Number C difficile reports from that Trust for the time period}}{\text{Total bed - days, in that Trust, for patients aged} \geq 6\,5 \text{ years over the time period}} \right] \times 1000$$

C. difficile microbiological investigations: strain typing

Mandatory surveillance: Sampling programme

Mandatory surveillance of *C. difficile* infection also includes a microbiological testing component to identify the epidemiological types and antimicrobial susceptibilities of a sample of strains from English NHS acute Trusts. Trusts are allocated a week in which to send a defined number of patient stool samples which were found to be positive for *C. difficile* toxins for further microbiological investigations. Positive specimens are sent to the local Regional HPA laboratory for culture for *C. difficile*. Isolates of putative *C. difficile* are then referred to the Anaerobe Reference Laboratory (ARL) in Cardiff for PCR ribotyping and susceptibility testing.

Clinical referrals

A network of six regional HPA laboratories (CDRNE) has been established to undertake microbiological investigation of *C. difficile* positive specimens referred for clinical reasons, such as investigation of a cluster of cases to identify whether it represents an outbreak or increased severity of infections. The laboratories are in Leeds (Reference Laboratory, Leeds General Infirmary), Birmingham (Heartlands Hospital), London (HPA Collaborating Centre at University College Hospital), Manchester (Manchester Royal Infirmary), Newcastle (Newcastle General Hospital) and Southampton (Southampton General Hospital). The number of samples to be submitted for testing in these situations is agreed prospectively between the referring microbiologist and the Regional Microbiologist, according to the clinical situation being investigated.

Surgical site infections

Hospitals participating in the Surgical Site Infection Surveillance Service (SSISS) should use the surveillance methods described in a comprehensive protocol and undertake surveillance for a minimum of three consecutive months. The service is available to hospitals from both the NHS and independent sector. All NHS Trusts providing orthopaedic services are required to undertake surveillance for a minimum of three months per financial year in at least one orthopaedic category as part of the Department of Health's mandatory HCAI surveillance programme. Aside from this, hospitals can undertake surveillance in one or more of 13 categories of surgical procedure. The procedures included in each category are defined by a set of OPCS procedure codes. Hospitals participating in the surveillance are required to collect a set of demographic and operation data on all patients undergoing a surgical procedure in the chosen category, and then actively monitor each patient during their post-operative hospital stay to identify those who develop an SSI that meets the standard case definitions.

Data are submitted to SSISS via a web-based system that enables errors and inconsistencies to be flagged and corrected on data entry. At the end of each surveillance quarter each hospital is sent a report containing their results together with comparisons with benchmark data from all participating hospitals.

Appendix 3.

Definitions of Trust types*

Small Acute Trust: A Trust with 85% or more of its expenditure in acute specialties (medicine, surgery, A&E and maternity), an A&E department, all core acute specialties and an annual expenditure of up to £80million (based on Trust Financial Return data for 2002/03).

Medium Acute Trust: A Trust with 85% or more of its expenditure in acute specialties (medicine, surgery, A&E and maternity), an A&E department, all core acute specialties and an annual expenditure of between £80-£130 million (based on Trust Financial Return data for 2002/03).

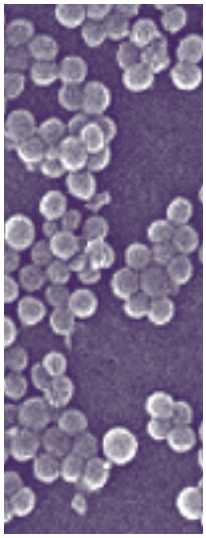
Large Acute Trust: A Trust with 85% or more of its expenditure in acute specialties (medicine, surgery, A&E and maternity), an A&E department, all core acute specialties and an annual expenditure of more than £130million (based on Trust Financial Return data for 2002/03).

Acute Teaching Trust: A Trust participating in teaching, which is attached with an undergraduate medical school.

Acute Specialist Trust: A Trust with restricted specialties.

Acute Specialist Childrens Trust: A Trust with restricted specialties for children.

*Trust categorisation information obtained from the NHS Information Centre.



References

1. *Surgical Site Infections: IPSE Newsletter* [serial online] 2007[cited 8th July 2008] Year 3, No 1, available at: http://ipse.univ-lyon1.fr/deliverables/Newsletter_Y3_Issue1_website.pdf

2. *The Third Prevalence Survey of Healthcare Associated Infections in Acute Hospitals 2006: Summary of Preliminary results, 27 February 2007* [cited 8th July 2008], available at: http://www.his.org.uk/_db/_documents/Summary_of_preliminary_results_for_England.pdf

3. *Steering Group on Healthcare-Associated Infections. Final report, August 2007* [cited 8th July 2008], available at: http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb_C/1195733803379

4. Health Protection Agency website: *Topics A-Z* [cited 8th July 2008], available at: http://www.hpa.org.uk/webw/HPAweb&Page&HPAwebAutoListName/Page/1190280169369?p=1190280169369

5. Coello R, Charlett A, Wilson J, Ward V, Pearson A, Boriello P. Adverse impact of surgical site infections in English hospitals *J. Hosp. Infect* 2005; **60**: 93-103

6. Gastmeier P, Sohr D, Brandt C, et al. Reduction of orthopaedic wound infections in 21 hospitals. *Arch Orthop Trauma Surg* 2005; **125** (8):526-530.

7. Mangram A.J., Horan T.C., Pearson M.L., Silver L.C. and Jarvis W.R. Guideline for Prevention of Surgical Site Infection *American Journal of Infection Control*. 1999; **27** (2): 96-134.

8. *HPA Training Resource Pack for Care Homes, North West HPU* [cited 8th July 2008], available at: http://www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb_C/1195733826401?p=1199451893840%20

9. *Antibiotic Resistance Surveillance & Control in the Mediterranean Region: ARMED* [cited 8th July 2008], available at: http://www.slh.gov.mt/armed/harmony.asp

10. *National Confidential Study of Deaths Following Meticillin-Resistant (MRSA) Infection*. London: Health Protection Agency, November 2007 [cited 8th July 2008], available at: http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1194947311070

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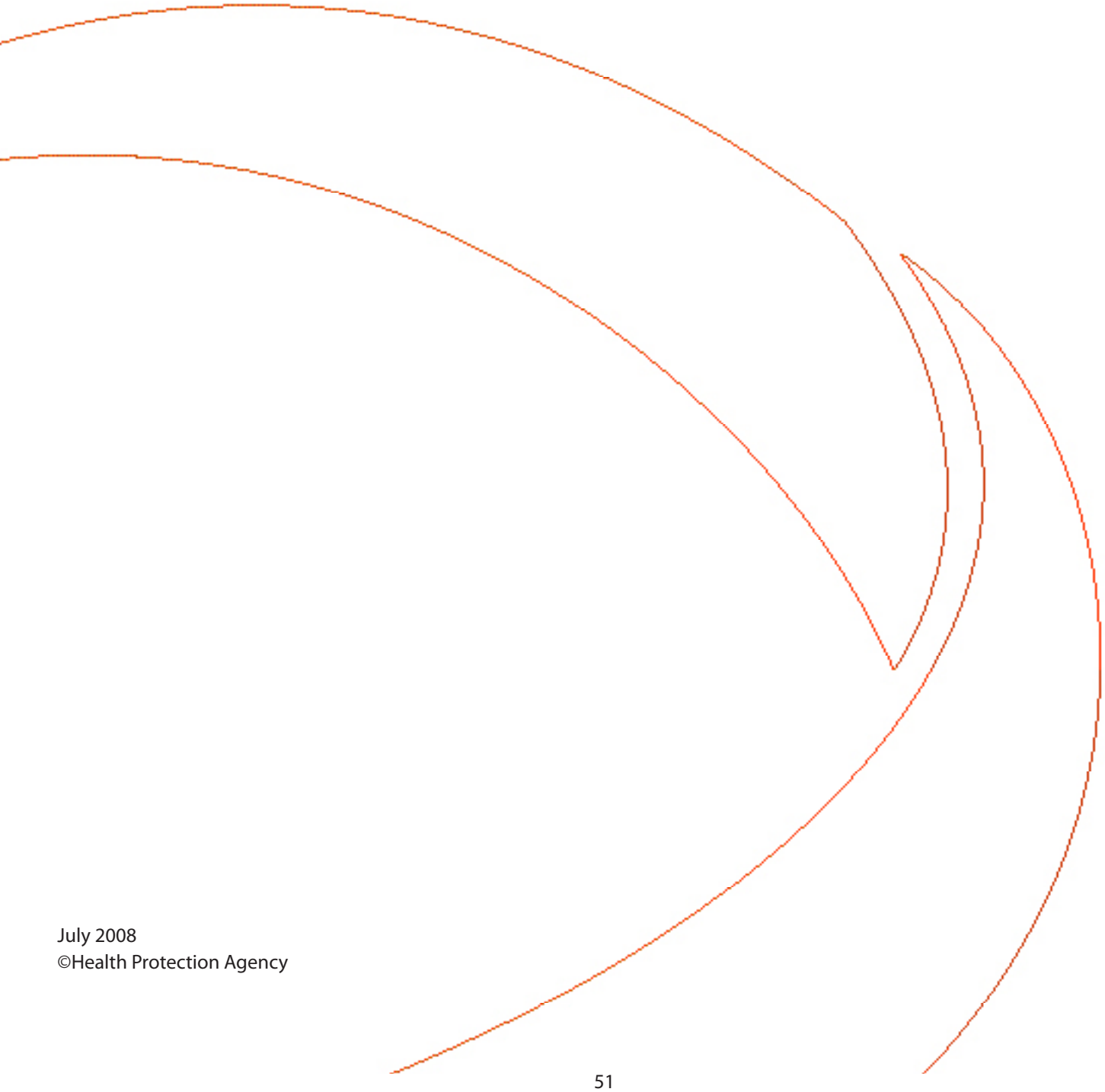

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