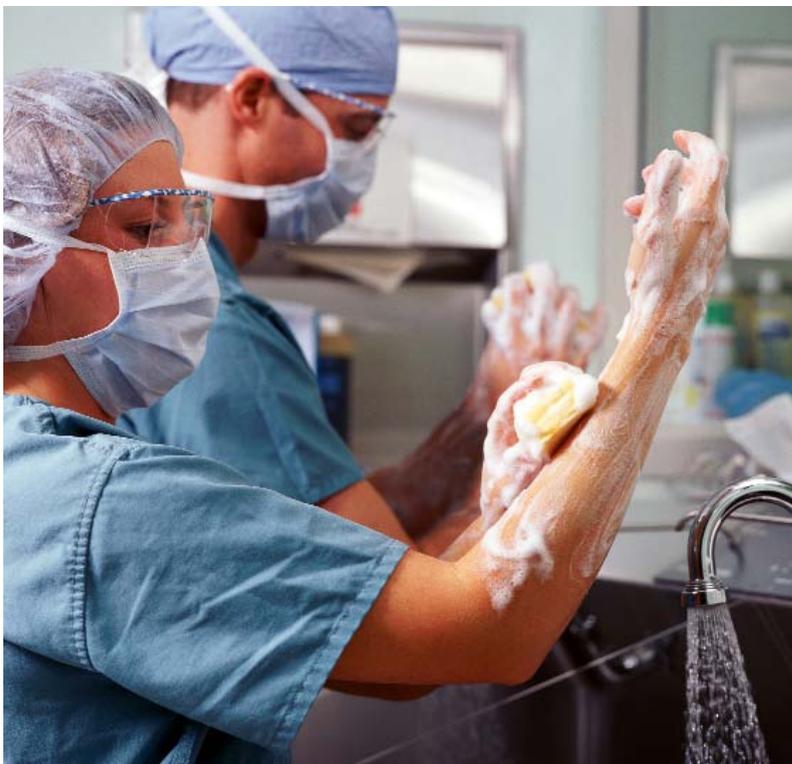


Surveillance of Healthcare Associated Infections Report 2007



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Acknowledgements

The Surveillance of Healthcare Associated Infections Report 2007 was prepared by members of the HCAI & AMR Department. This would not have been possible without the much valued contributions from Infection Control and Microbiology colleagues in NHS Trusts across England and those in the HPA's Local and Regional Services.

Foreword

Last year in the first report on healthcare-associated infections (HCAI) it was stated that this topic was high profile. The profile is now even higher, raised by the Government's drive to reduce the rates of MRSA bloodstream infections and growing concern about the level of *Clostridium difficile* (*C. difficile*) infections. The period since the last report has seen three publications by the Healthcare Commission on investigations into *C. difficile* outbreaks (Stoke Mandeville Hospital, Buckinghamshire Hospitals NHS Trust; University of Leicester NHS Trust and Maidstone and Tunbridge Wells NHS Trust); the arrival of the Code of Practice for prevention and control of HCAI, part of the Health Act 2006; announcement of a new Bill placing responsibility on Chief Executives to report MRSA and *C. difficile*, backed by fines; numerous Department of Health announcements of measures to control HCAI from deep cleans to uniforms to screening; the setting of a local target for *C. difficile*, recently superseded by a national target; the introduction of enhanced surveillance of *C. difficile*, quarterly publication of the MRSA bacteraemia and *C. difficile* data by individual Trust; establishment of a system to monitor MRSA bloodstream infections between renal hubs and their satellite units; plus significant changes to improve the quality of the data, including Trust Chief Executive sign-off, and the establishment of systems to assess whether some MRSA bloodstream infections which were not acquired in the Trust should be excluded from its count against the target.

Many of the developments to prevent and control MRSA and *C.difficile* infections have been underpinned by the establishment of real-time web-based mandatory surveillance. The linking of this surveillance to strong performance management of acute Trusts against a national target has not been seen anywhere else in the world. Rigorous performance management has become the public health intervention to drive down rates of infection – very different from traditional approaches in hospital infection control.

So, what has been the effect of all this activity? Mandatory surveillance of MRSA bloodstream infections increased reporting by around 40% against the earlier surveillance system. When we published in 2006, MRSA numbers were beginning to show a slight fall, but it was premature to state then that this marked a downturn in the trend. However, the downward trend has continued and we are now confident that this heralds 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. However, the situation with *C. difficile* is different. Numbers of infections are high and have increased dramatically over the past 15 years. They may still appear to rise, despite the many recent measures to control infection, as ascertainment of infection improves due to changes in the surveillance system. Other surveillance developments are in the wings, such as extension of mandatory surveillance to the independent healthcare sector and further developments to *C.difficile* surveillance to monitor Trusts against the new national target, whilst some others are overdue and necessary extensions to the current package of HCAI surveillance, for instance, monitoring of adverse incidents associated with healthcare infections and post-discharge surveillance for surgical site infection. Other areas of healthcare-associated infection surveillance warranting attention include infections in critical care units and in immuno-compromised patients.

As before, it is important to state that not all HCAI are preventable. However, the results in this report show that there can be, and have been, significant reductions for some infections. This is particularly notable for MRSA bloodstream infections, particularly when these infections are placed in the context of significant increases in hospital activity, mirrored in the rising numbers of blood cultures taken. Not only have numbers of blood cultures taken been rising, but the numbers found to be positive (all micro-organisms) have kept pace, suggesting a changing patient population. In the circumstances of increasing numbers of patients with serious underlying disease, it would be expected that rates of healthcare-associated bloodstream infections would rise. However, the MRSA bloodstream infection picture above shows that this is not occurring – rates are falling against the odds. This is a major achievement against the seemingly unstoppable rise in MRSA bloodstream infections throughout the 1990s. We cannot be complacent, however, as new epidemiological types of community-acquired *S.aureus* bloodstream infections are being described around the world. Existing surveillance schemes will need modifying to identify the presence of such strains, as well as to define the contribution of community-acquired infection to subsequent transmission of *S. aureus* and *C.difficile* infections in the acute sector and community and primary care facilities.

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Introduction

This is the second report on HCAI, which focuses on those infections subject to mandatory surveillance. However, it places them in the context of broader surveillance, not currently mandatory, of bloodstream infections and surgical site infection. This gives a broader perspective and sometimes additional information which then inform the findings from the mandatory surveillance.

This report covers general trends in bloodstream infections, with an emphasis on changes in recent years and the infections subject to mandatory surveillance, MRSA and glycopeptide-resistant enterococcal bacteraemia; *C. difficile* infection; and surgical site infection.

As mandatory surveillance of HCAs started at different times, this report deals with different periods, covering the latest year of the mandatory surveillance and comparing this with previous years. Thus we report on the sixth year of *S. aureus* bacteraemia surveillance and the third years of glycopeptide-resistant enterococcal bacteraemia, *C. difficile* infection and orthopaedic surgical site infection. Some of the data will have been published before for the separate surveillance systems, on completion of the relevant surveillance year, as the frequency of reporting of the results varies: quarterly for *S. aureus* bacteraemia and *C. difficile* infection, annually for orthopaedic surgical site infection and glycopeptide-resistant enterococcal bacteraemia.

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.

Executive Summary

This is the second report on HCAI, focussing on those infections subject to mandatory surveillance, but placing them in the context of broader surveillance of bloodstream infections and surgical site infection.

It covers general trends in bloodstream infections; mandatory surveillance of *Staphylococcus aureus* (*S. aureus*) and glycopeptide-resistant enterococcal (GRE) bloodstream infections and *C. difficile* infection; and general surgical site infection surveillance, as well as mandatory surveillance of orthopaedic surgical site infection. As mandatory surveillance of HCAs started at different times, this report deals with different periods, covering the latest year of the mandatory surveillance and comparing this with previous years. Thus we report on the sixth year of *S. aureus* bacteraemia surveillance and the third years of glycopeptide-resistant enterococcal bacteraemia, *C. difficile* infection and orthopaedic surgical site infection. Given different reporting frequencies for the separate elements of mandatory surveillance, some of these data will have been published before, but are brought together for the first time in this report.

The main changes that have occurred include a continuing downward trend in MRSA bloodstream infections and also in rates of surgical site infections. Some NHS Trusts have made a significant impact on their MRSA bloodstream infection rates. This is against a backdrop of changing hospital activity. Rising numbers of blood cultures taken and their positivity rate (all micro-organisms) suggest that not only is there increasing hospital activity, but that this is increasingly focussed on both a more elderly population and in patients with health seriously compromised by underlying disease. Circumstances in which healthcare-associated infections would be expected to rise. The incursions made into MRSA bloodstream infections have not yet translated across to *C. difficile* infections, where numbers are continuing to rise, albeit at a slower rate. Numbers are also rising for glycopeptide-resistant enterococcal bloodstream infections, but are still low in the majority of Trusts. Many Trusts have not yet had experience of these infections, but their numbers are falling since the beginning of the surveillance. More detail on the data and trends are given below and in the body of the text. The healthcare-associated infections considered in this report are largely conditions affecting the elderly, over three-quarters of MRSA bloodstream, *C. difficile* and surgical site infections occurring in those aged 65 years or over.

The surveillance also highlights some challenges and areas for further consideration: the surveillance system for *C. difficile* is undergoing significant enhancement to better monitor infection against the target. This is likely to have an impact on the data. As ascertainment improves, levels of infections are likely to rise further, before the effect of interventions is seen. General surveillance of bloodstream infections indicates that there are significant increases in infections caused by other micro-organisms where an element of the increase may be healthcare-associated in patients with compromised immune systems – for instance, coagulase-negative staphylococci and *Candida* species. Nationally there is little information on healthcare-associated infections in this very vulnerable group of patients – an area warranting further investigation. The rise in glycopeptide-resistant enterococcal bloodstream infections, albeit from a low base, suggests that there should be a focus of action on affected units in Trusts and consideration of suitable control measures whilst the size of the problem is still small. It is important that measures to prevent SSI caused by MRSA are incorporated into patient care plans. Marked reductions in length of post-operative stay for elective surgery mean that the surveillance data for surgical site infection will become increasingly unreliable. Consequently there is an urgent need to

develop systems that capture data on surgical site infections that become apparent after the patient has been discharged from hospital.

Bloodstream Infections

Trends in bloodstream infections

- Numbers of blood cultures taken in acute NHS Trusts have increased by 17% between 2002 and 2006, culminating in 1,752,914 in 2006. Those found to be positive (all micro-organisms) increased by 14% over this period to 285,152 in 2006, the proportion that were positive remaining unchanged at 17% over these years. This is suggestive of increasing hospital activity and a changing case-mix of patients.
- In 2006, *Escherichia coli* was the most frequently isolated micro-organism from blood cultures reported via the traditional, non-mandatory, laboratory reporting scheme, followed by coagulase-negative staphylococci and *S.aureus*. Most *E. coli* infections are likely not to be hospital-acquired.
- Since 2002, the largest increases in bloodstream infections reported to the HPA via this surveillance include coagulase-negative staphylococci (114% increase), *Candida* spp. (62% increase), *Enterococcus* spp. (60% increase), and *Klebsiella* spp. (49% increase). A significant component of these infections might be healthcare-associated, but this requires further exploration.
- The incidence of bloodstream infections is low in the under-60s, rising rapidly in older age groups. This is likely to reflect a rising incidence of underlying clinical conditions with age.

Staphylococcus aureus bloodstream infections

- Mandatory surveillance of *S. aureus* bloodstream infections has resulted in approximately a 40% increase in reporting of these infections compared to traditional laboratory reporting (voluntary).
- There were 17,404 *S. aureus* bloodstream infections in the latest year of mandatory surveillance, of which 6381 were due to MRSA.
- There has been a 12% decrease in reported cases of methicillin-resistant *S. aureus* (MRSA) bloodstream infections over the six years of the mandatory surveillance scheme to March 2007. The downturn has been marked from 2003/4, with a 10% reduction in MRSA bloodstream infections between the fifth and sixth years of the surveillance (2005/6 to 2006/7). Methicillin-susceptible *S. aureus* bloodstream infections have not fallen to the same extent in most types of hospital.
- London has been the region with the largest numbers of MRSA bloodstream infections and has had the largest reductions. Rates of MRSA bloodstream infections have been falling in all regions since September 2006.
- Reductions in rates of MRSA bloodstream infections are occurring in all types of acute NHS Trust; this is most marked in the acute teaching category of Trust.
- MRSA bloodstream infection is a disease of the elderly, 69% occurring in those aged 65 or over.
- A significant proportion of MRSA bloodstream infections are present on admission; it is not clear yet to what extent these infections are healthcare-associated. 65% of MRSA bloodstream infections are acquired during the admission.
- Patients with MRSA bloodstream infections incubating on admission are more likely to have been admitted from nursing homes than those acquiring their infection during the admission.

- Some specialties, such as nephrology, contribute disproportionately to the burden of MRSA bloodstream infections. Whilst four specialities account for the highest risk rates (nephrology, gastroenterology, general surgery and cardiosurgery), the greatest burden in terms of numbers remain in general medicine and surgery.

Glycopeptide-resistant enterococcal bloodstream infections

- Numbers of these infections are much smaller than MRSA bloodstream infections – 903 reports in the latest complete year of the mandatory surveillance ending in September 2006.
- However, there has been a 19% increase in bloodstream infections compared with the previous surveillance year.
- The proportion of acute NHS Trusts reporting these bloodstream infections has risen to 76% from 69% in the previous year.
- 41 Trusts reported no bloodstream infections with this micro-organism, falling from 75 at the beginning of this mandatory surveillance in October 2003/September 2004.
- 20 Trusts had more than 10 bloodstream infections, a rise from 14 at the beginning of the surveillance.

Clostridium difficile infection

- This report describes results from the third year of the mandatory *C. difficile* case reporting scheme in England, January to December 2006. Mandatory surveillance has increased case ascertainment by approximately 30% over traditional laboratory reporting.
- Reports were received from all 168 acute Trusts treating adult patients in England. One Trust however only reported data for two of the four quarters.
- Numbers of *C. difficile* are high and still rising: there were 55,620 reports of *C. difficile* in people aged 65 years and over in 2006, a 7% increase from 2005.
- However, the year-on-year increases in the number of *C. difficile* reports received via mandatory reporting appear to have slowed down in 2006: the increase between 2004 and 2005 was 16% whereas the increase between 2005 and 2006 was only 7%.
- 84% of *C. difficile* infections occur in those aged 65 or over.
- Rates of infection have been rising in all categories of NHS acute Trusts, but have been most marked in small acute Trusts. The largest numbers (but not rates) occur in large acute Trusts; the lowest rates are in acute specialist Trusts.

Surgical Site Infection

- Hospital participation in broader Surgical Site Infection surveillance (non-mandatory) has been increasing.
- 261 hospitals contributed data on 260,671 operations and 5,113 SSIs between April 2002 and March 2007. Rates of infection ranged from 0.7 to 8.1 infections per 1000 post-operative days, 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. Rates were lowest in hip and knee prosthesis surgery.
- For most categories of surgery, there has been a downward trend in the rate of SSI over the period, with the exception of large and small bowel surgery and coronary artery bypass graft surgery, where there was no clear trend. Trends may be affected by fluctuations in the number of procedures or changes in the hospitals contributing data and so caution needs to be exercised in their interpretation.
- The downward trends are significant in three of the orthopaedic categories, even when reductions in length of post-operative stay are taken into account.
- The risk of infection rises with the number of risk factors present, including age.

- Most infections were superficial.
- *S. aureus* accounted for most infections (39%); Enterobacteriaceae accounted for 21% of SSIs.
- In the third year of the mandatory surveillance of SSI in orthopaedics eight Trusts had higher than expected rates of infection, three of these being high outliers in more than one category of procedure. These Trusts were asked to investigate possible causes for their higher rates.
- A small number of Trusts have unusually low rates of SSI, which might reflect high standards of clinical practice, short post-operative hospital stays or under-reporting of infection.
- Decreasing length of post-operative stay in hospital means that the surveillance is increasingly likely to underestimate the true rate of SSI, affecting the interpretation of changes in rates over time.

1. Bloodstream Infections

1.1 Introduction

Bloodstream infections are estimated to account for 6% of all healthcare-associated infections and are commonly linked with invasive procedures undertaken in healthcare settings, such as intravenous devices or surgery¹. They can be caused by a wide variety of micro-organisms. These are often micro-organisms carried by the patients themselves which have taken advantage of a route into the body provided by an invasive device or procedure, but sometimes they may come from another person or the environment. Infections receiving the most attention are often those caused by antibiotic-resistant micro-organisms, such as methicillin-resistant *Staphylococcus aureus* (MRSA) or multi-resistant *Acinetobacter spp.* These do not generally cause different infections from their antibiotic-susceptible counterparts, but may have particular characteristics that enable them to spread easily between patients and the infections they cause can be more difficult to treat. Sometimes these antibiotic-resistant micro-organisms can replace a patient's normal flora of micro-organisms without causing infection (carriage or colonisation), but these patients can then act as a reservoir from which the antibiotic-resistant micro-organisms can contaminate the environment or be transferred to other patients.

Bloodstream infections are an important source of surveillance information as they represent the severe end of the spectrum of infection and the 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. The HPA's Department of Healthcare Associated Infection and Antimicrobial Resistance (HCAI & AMR) undertakes surveillance of bloodstream infections (including bacteraemia and fungaemia) in England through a number of methods. The main source of surveillance data is the HPA's microbiology reporting database ("LabBase2") to which hospital microbiology laboratories voluntarily report data on clinically significant specimens. Data collection is mainly electronic and continuous, with most laboratories reporting data on a weekly basis. Data collected includes identity of pathogen (usually to species level), antimicrobial susceptibility and patient demographics such as age and gender. As microbiology laboratories provide services across healthcare sectors, this surveillance is truly population-based, representing diagnoses made across patient groups. The scheme has been growing for over fifty years, laboratory reporting of significant pathogens originally being established by the Emergency Public Health Laboratory Services (EPHLS) during World War II, but developing significantly under the Public Health Laboratory Service (PHLS). The proportion of laboratories reporting and the completeness of reporting has grown over the years. This is the bedrock of national surveillance, good laboratory participation making this one of the most complete surveillance datasets in the world. The data on bloodstream infections are particularly useful as these infections are a marker of severity.

In addition to routine laboratory reporting described above, the HPA also co-ordinates the Department of Health's mandatory surveillance schemes for bloodstream infections caused by *S. aureus*, both methicillin-resistant (MRSA) and methicillin-sensitive (MSSA) *S. aureus*, since April 2001, and glycopeptide-resistant enterococci (GRE), since October 2003. These mandatory schemes were introduced under the auspices of the Department of Health and were designed to obtain more robust estimates of the incidence of these infections for individual hospital Trusts, laboratory reporting being difficult to translate into Trust-level data given the complex arrangement of microbiology services within Trusts.

This section reports on the incidence and identification of bloodstream infections in England from 2002 to 2006, focusing on changing trends in bloodstream infections and those caused by *S. aureus* and glycopeptide-resistant enterococci. This draws on information from both the traditional voluntary reporting schemes and the more recent mandatory surveillance schemes, as they bring different strengths: the voluntary surveillance data show trends over very many years for the main pathogens with additional clinical information (laboratory-based), whilst the mandatory surveillance gives accurate information from all English acute NHS Trusts on a small number of pathogens over a shorter period. Comparing the two allows us to estimate the shortfall in voluntary reporting and use this to assess the burden of infection from pathogens not included in mandatory surveillance. Analytical methods are described in Appendix 1. Analyses of trends are regularly reported for the main human pathogens detected in blood cultures (accessible from the HPA's [‘Topics: A to Z’](#) website). These analyses include relevant antimicrobial susceptibilities.

1.2 Trends in bloodstream infections in England, 2002 to 2006

Reporting of total number of blood cultures taken and the number found to be positive for one or more (“polymicrobial”) micro-organisms form part of the mandatory surveillance system for bloodstream infections (Table 1). In the five years since 2002 the number of reported blood cultures has increased by 17%, while the number testing positive has increased by 14%. The proportion of blood cultures positive for at least one micro-organism has remained unchanged during the five years at 17% - ranging from 16% in 2006 to 17% in 2004.

Table 1: Blood culture testing in England, 2002 to 2006 (mandatory and voluntary surveillance)

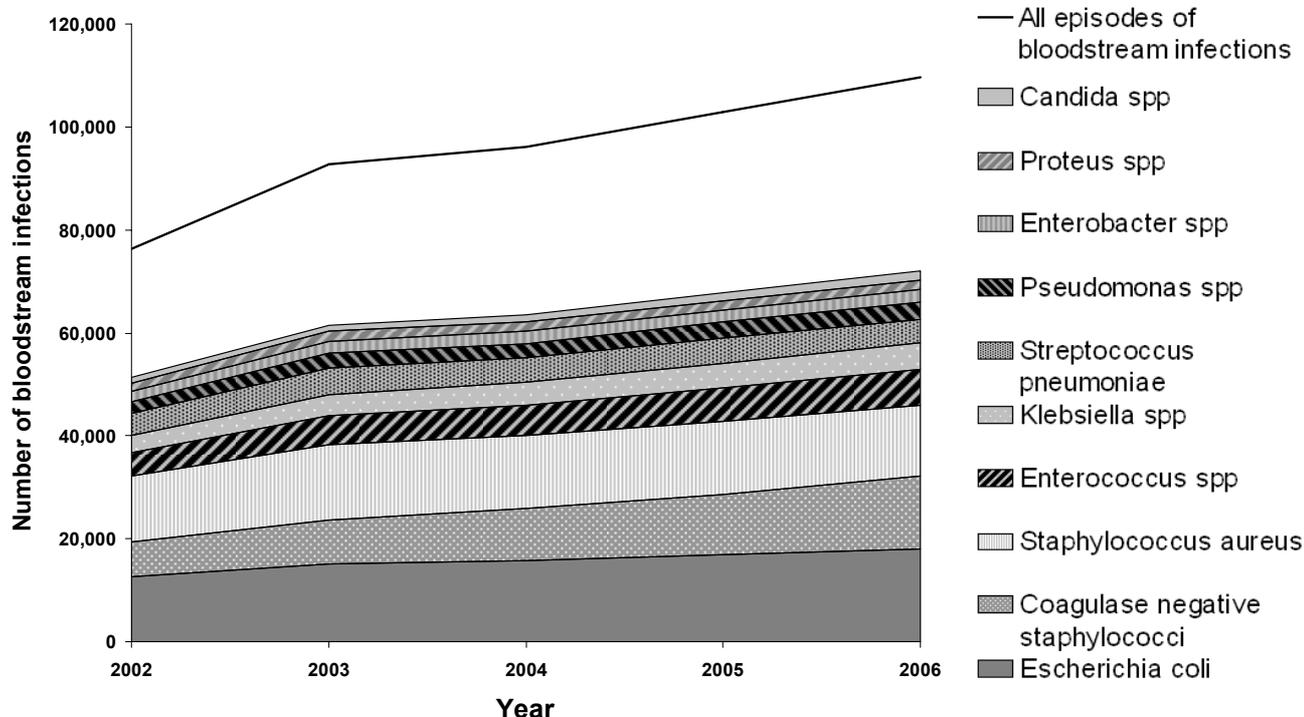
	2002	2003	2004	2005	2006
Total blood cultures (mandatory surveillance)	1,500,832	1,611,714	1,546,630	1,695,371	1,752,914
Total positive blood cultures (mandatory surveillance)	249,311	264,766	261,899	278,281	285,152
Total significant positive blood cultures (voluntary surveillance)	81,318	99,086	103,005	110,292	118,684
Total patient episodes (voluntary surveillance)	76,231	92,770	96,101	102,785	109,696

The total number of reports on blood cultures with significant pathogens to the HPA as part of the traditional voluntary surveillance system is less than from the mandatory system, partly owing to the removal of positive specimens not considered clinically significant in this system, and partly reflecting incomplete participation by laboratories in this surveillance. However, these data are invaluable for determining trends for the most frequently reported pathogens isolated from blood (Figure 1). These numbers have increased more over the period - 46% - reflecting in part improved participation by laboratories in this surveillance. In 2006 microbiology data for 118,684 blood culture isolates were reported to the HPA, representing 109,696 bloodstream (mono- and poly-microbial) patient episodes.* The 44% increase in

* A single patient episode includes all positive blood cultures taken from a patient within two weeks of first positive blood culture, and represents all micro-organisms that may have been identified during this time period. Please refer to Appendix 1 for further information regarding patient episodes.

patient episodes reported to the HPA since 2002 (76,231 episodes) is consistent with the overall voluntary reporting of positive blood cultures and suggests the incidence of polymicrobial infections is unchanged during this period.

Figure 1: Bloodstream infections in England, 2002 to 2006 (voluntary surveillance)



In 2002, *S. aureus* was the most frequently reported cause of bloodstream infection; however, in 2006 it was the third most frequently reported cause of bloodstream infection, behind *Escherichia coli* and coagulase-negative staphylococci (CNS). Since 2002, the greatest increases of bloodstream infection have been reported for CNS (114%), *Candida* spp. (62%), *Enterococcus* spp. (60%), and *Klebsiella* spp. (49%). The smallest increases among these top-ten organisms were for *S. aureus* (6%), *Streptococcus pneumoniae* (9%), and *Proteus* spp. (11%).

The increased rate of CNS bacteraemia 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 rising rate of CNS bacteraemia reported here may be due, in part, to microbiologists' increasing tendency to consider CNS bacteraemia as clinically significant.

The increased rate of bloodstream infections associated with *Candida* species is likely to reflect a growing population of patients with compromised immune systems, either as a result of underlying illnesses or immunosuppressive therapy. Like CNS, infection usually arises when there have been breaches of the normal defences against infection. Many countries, including the UK, have reported marked increases in the incidence of candidaemia over the past decade²⁻⁴, placing *Candida* at an increasingly higher rank as a cause of healthcare-associated bloodstream infection. Mortality following infection tends to be high, particularly in children^{5,6}. The marked increase in rates of candidaemia reports seen in 2005 showed further increase in

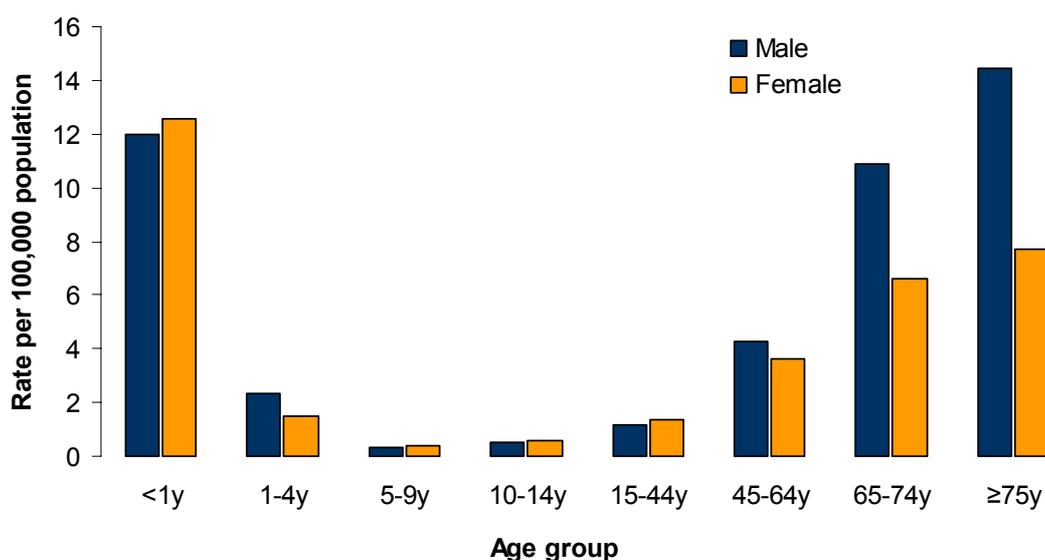
2006, with *Candida* species now accounting for 2% of all bloodstream infections in England. A total of 1696 reports of candidaemia (3.34 per 100,000 population) were made in England in 2006, a further increase from 2005 (1573; 3.12/100,000). Population-based rates of infection in the UK are broadly in line with those observed in other European countries, although lower than estimates from the US². Although *Candida albicans* remains the most common species reported, many countries have noted increases in non-*albicans* species, especially *Candida glabrata*, worrying developments given the inherent resistance of some of these species to antifungal therapy. In England, *Candida albicans* accounted for 53% of candidaemia reports in 2006 where the species was indicated, with *Candida glabrata* (18%) and *Candida parapsilosis* (11%) the next most common species identified (Table 2).

Age and sex-specific rates of infection showed a marked concentration in infants (<1 year old) and the elderly, with rates being higher in males and females across all age groups, but most markedly in the elderly (75 years and over) where rates in males were double those for females, 14.47 and 7.71/100,000 respectively (Figure 2).

Table 2: Laboratory reports of candidaemia by species, England 2006

Species	Number of reports	(%)
<i>Candida albicans</i>	904	(53%)
<i>Candida famata</i>	10	(1%)
<i>Candida glabrata</i>	304	(18%)
<i>Candida guilliermondii</i>	19	(1%)
<i>Candida kefyr</i>	2	(0%)
<i>Candida krusei</i>	20	(1%)
<i>Candida lusitanae</i>	17	(1%)
<i>Candida parapsilosis</i>	187	(11%)
<i>Candida tropicalis</i>	54	(3%)
<i>Candida</i> spp. - species not recorded	154	(9%)
<i>Candida</i> spp. - other named	25	(1%)
Total	1696	(100%)

Figure 2: Age-specific rates of candidaemia per 100,000 population, England 2006



1.3 *Staphylococcus aureus* bloodstream infections

1.3.1 Introduction

Staphylococcus aureus is a bacterium that is commonly found on human skin and mucosa (e.g. lining of nose). The bacterium usually lives harmlessly on the skin and in the nose of about one third of normal healthy people. This is called colonisation or carriage. *S. aureus* can cause actual infection and disease, particularly if there is an opportunity for the bacteria to enter the body – for example, via a cut or an abrasion. Methicillin-resistant *S. aureus* (MRSA) are varieties of *S. aureus* that have developed resistance to the antibiotic methicillin. Methicillin is an old antibiotic which is used as an indicator for flucloxacillin resistance, the antibiotic which is usually used to treat *S. aureus* infections. Methicillin resistance usually indicates resistance to other penicillin-related antibiotics too. There are different types of MRSA, which either originate in the community or healthcare facilities. Most strains of MRSA in England currently originate in hospitals. The Health Protection Agency is able to carry out laboratory testing to distinguish between these types.

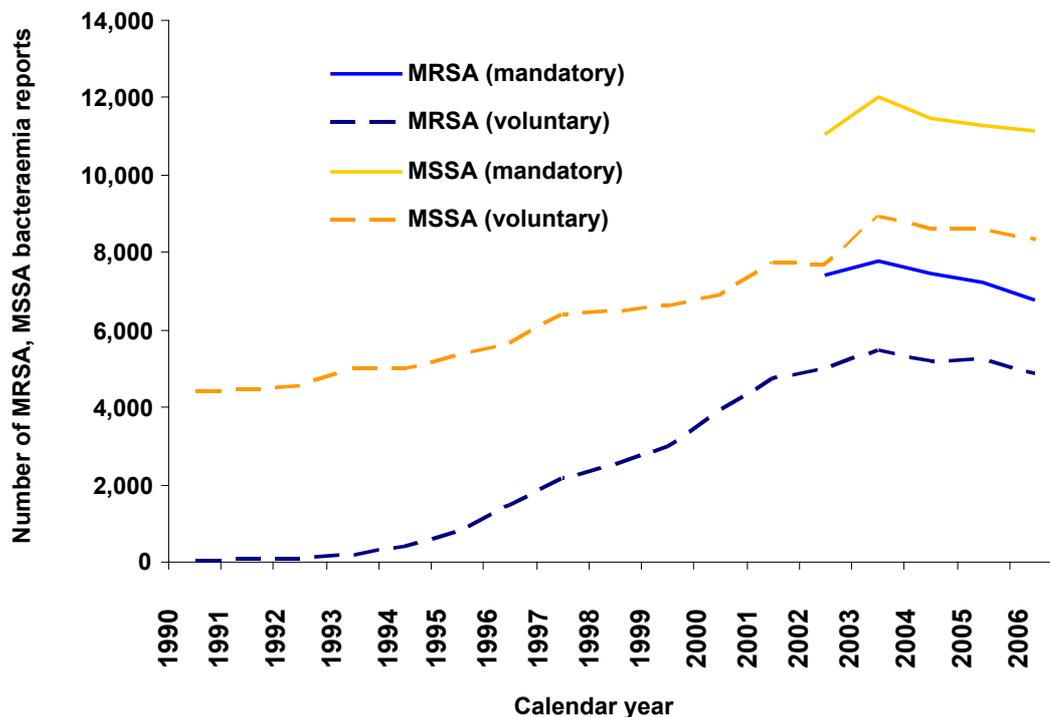
The Agency's database of laboratory reports (LabBase2) contains historical records for *S. aureus* bacteraemia that have been voluntarily reported to the HPA over many years. Analyses of these data recorded year-on-year rises in the proportion of *S. aureus* from blood that were methicillin-resistant from less than 5% in 1990 to around 40% by the end of the decade. Concerns about this increase led the then Health Minister to announce in October 2000 that the reporting of certain healthcare associated infections would become mandatory. This started with the mandatory surveillance of *S. aureus* bacteraemias by all acute NHS Trusts in England in April 2001. Initially the surveillance data were published annually, but subsequently this was changed to six monthly and, more recently, quarterly. Following a user study in 2004, which indicated that many Trusts were already collecting additional information on these bacteraemia, the scheme was developed further during 2005 at the request of the Department of Health (DH). These enhancements were launched in October 2005. This involved Trusts accessing a website to enter details about each MRSA bacteraemia episode detected in their Trust, such as patient details, information on the patient's location, date of admission, consultant specialty, and care details at the time the blood sample was taken. The data from the mandatory *S. aureus* bacteraemia surveillance system are used to inform performance management of English NHS acute Trusts against the national MRSA target. Analytical details are given in Appendix 1.

1.3.2 National, regional and Trust trends

These data include information on *S. aureus* bloodstream infections from both the original voluntary reporting system and the more recent mandatory surveillance (six years). The mandatory surveillance of *S. aureus* bloodstream infections comprises total numbers of *S. aureus* bacteraemia, with additional information on MRSA bloodstream infections.

Figure 3 shows the trend in *S. aureus* bloodstream infections since 1990 and the impact of mandatory surveillance in 2001. The increase in the number of *S. aureus* bloodstream infections prior to the mandatory system is likely to reflect changes in ascertainment as well as increases in the number of MRSA bacteraemias. 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.

Figure 3: *Staphylococcus aureus* bacteraemia reports received under the voluntary and mandatory surveillance schemes in England, calendar year 1990 to 2006.



There were 18,514 reports of *S. aureus* bacteraemia under the mandatory reporting system between April 2005 to March 2006, of which 7096 (38.3%) were MRSA (Figure 4). In the most recent surveillance year (April 2006 to March 2007), there were 17,404 *S. aureus* bacteraemia reports, of which 6381 (36.7%) were MRSA. These represent a 6% and 10% year-on-year decrease for *S. aureus* and MRSA bacteraemia, respectively.

Figure 4: *Staphylococcus aureus* bacteraemia and methicillin-resistant *Staphylococcus aureus* (MRSA), reported under the mandatory scheme, April 2001 to March 2007.

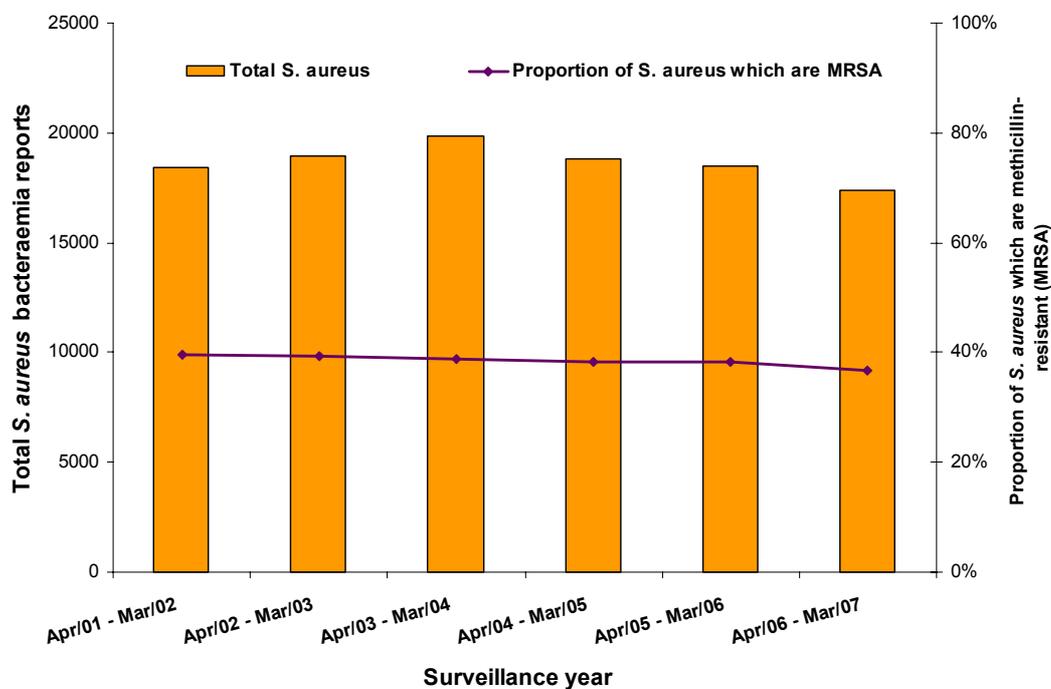
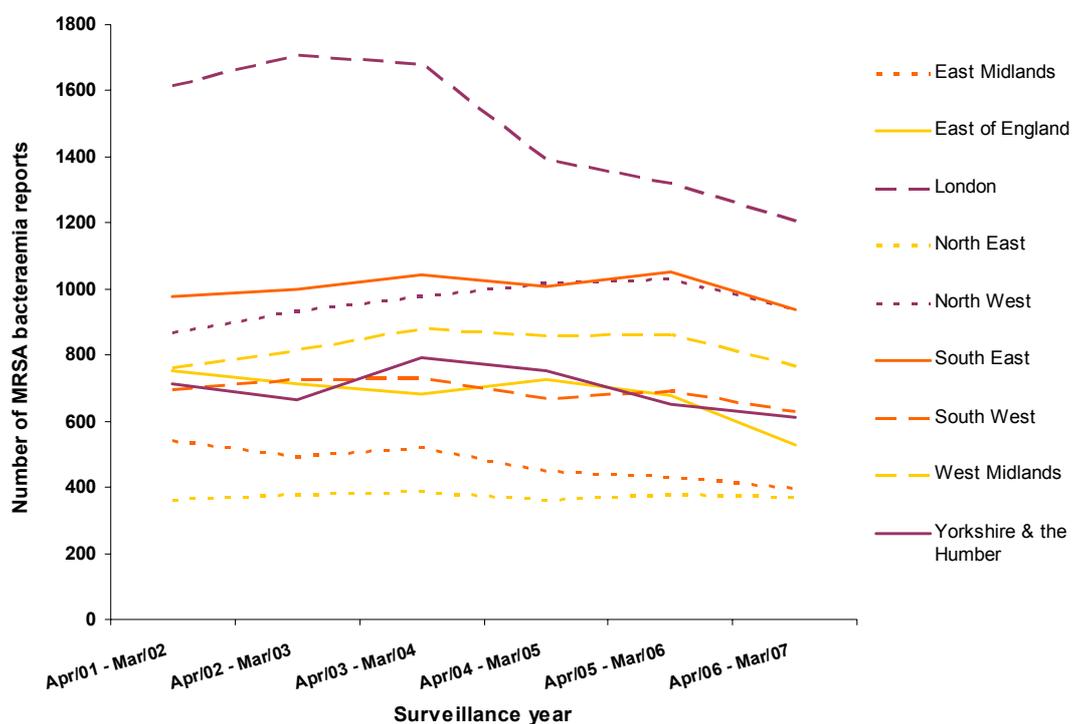


Figure 5 shows the regional distribution of reported MRSA bloodstream infections. London has had the largest number of reported MRSA bloodstream infections for all years of the reporting scheme, but it has also had the largest reductions. The number of cases of MRSA bacteraemia has dropped in every region for the period April 2006 to March 2007.

Figure 5: Regional distribution of MRSA bacteraemia reports, April 2001 to March 2007: numbers.



The differences in numbers between regions are partly attributable to differences in the sizes of the populations served. Figure 6 shows that when rates are considered these regional differences are not quite so marked. Although the highest rate for the period of April 2006 to March 2007 can be found in London (in line with figure 5), the highest rate reduction can be found in the East of England (the rate has decreased from 1.86 per 10000 bed days in FY 2005/06 to 1.51 per 10000 bed days in FY 2006/07). Since the scheme began in 2001, the East Midlands has had the largest rate reduction, from 2.36 per 10000 bed days in FY 2001/02 to 1.47 per 10000 bed days in FY 2006/07).

Figure 6: Regional distribution of MRSA bacteraemia reports, April 2001 to March 2007: rates.

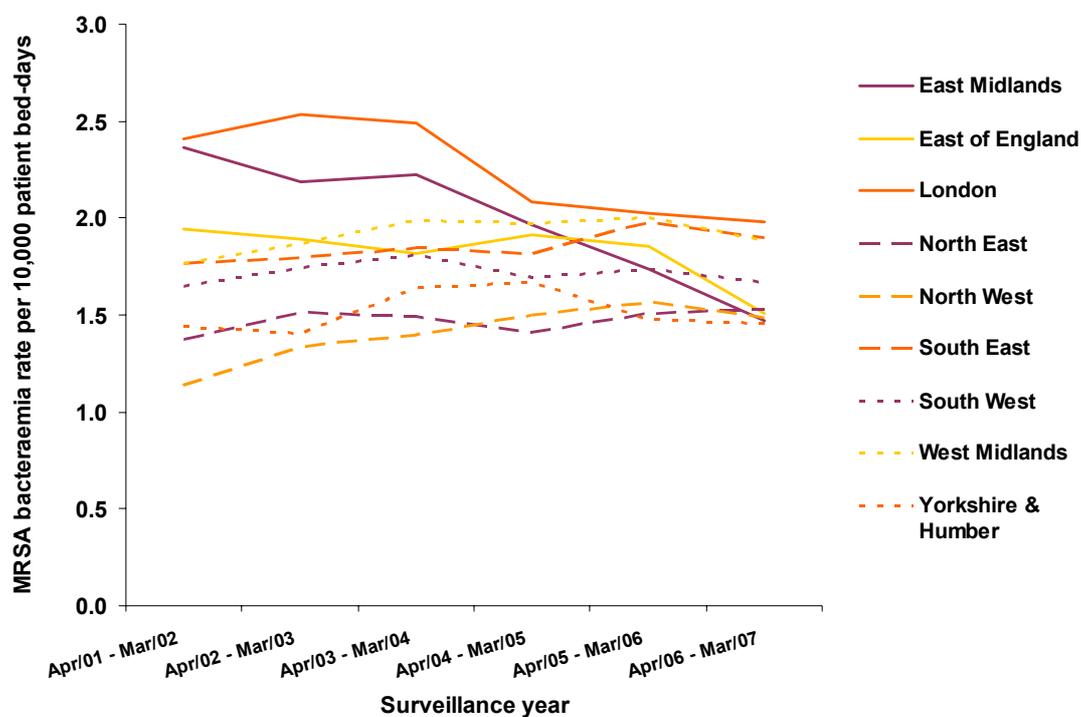
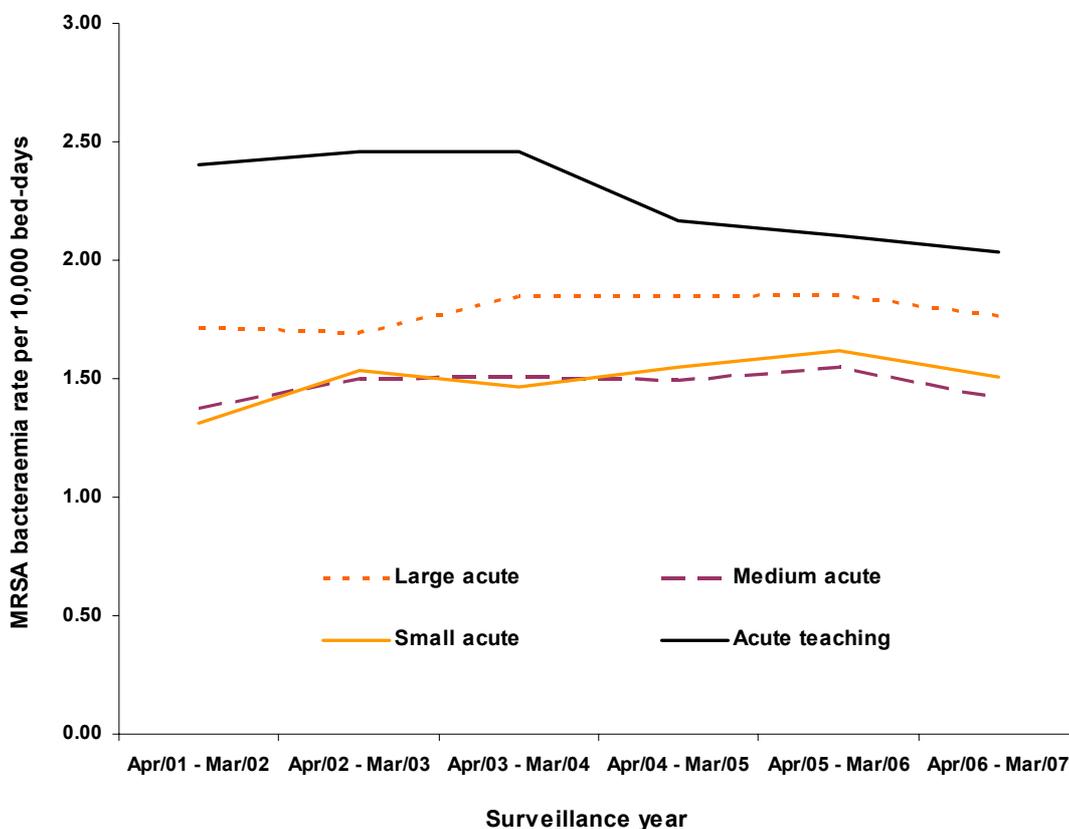


Figure 7 shows the MRSA bacteraemia rate by the four main (small, medium, large, and teaching) Trust categories (see Appendix 2 for glossary of Trust categories). There have been reductions in MRSA bacteraemia rates in all Trust categories in the past year (April 2006 to March 2007). These four categories account for almost 90% of all Trusts and the MRSA bacteraemia rate for each of these four categories has decreased by about 10% compared to the previous year (April 2005 to March 2006). The two remaining Trust categories (Specialist and Specialist Children) were not included due to the small number of Trusts.

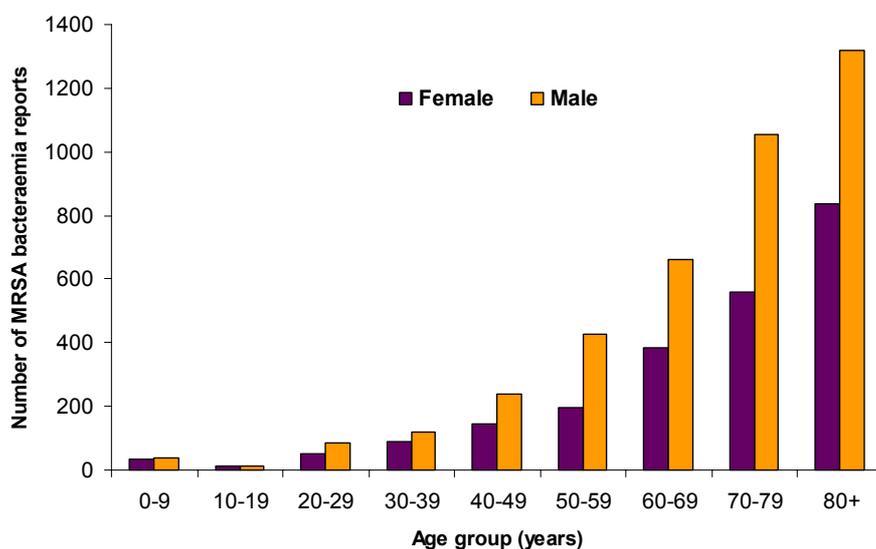
Figure 7: MRSA bacteraemia rate by Trust category: FY 2001/02 to FY 2006/07



1.3.3.1 Age and sex distribution

Information was available on both age and sex for 6,264 patients (98%) diagnosed with MRSA bloodstream infection between April 2006 and March 2007 (Figure 8). The number of reported cases increased with age and was greater among males than females. Seventy-seven per cent of cases occurred among those aged 60 years and over (69% in those aged 65 years and over).

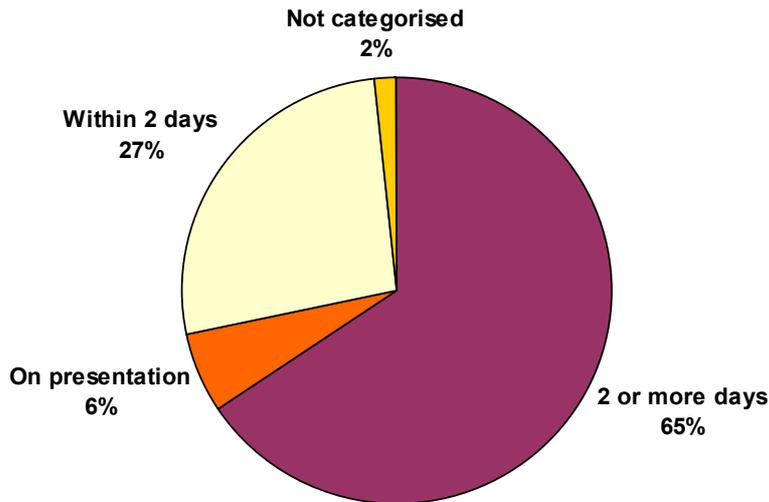
Figure 8: Age and sex distribution of MRSA bacteraemia, April 2006 to March 2007



1.3.3.2 Timing of Detection

65% of MRSA bacteraemias 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 9).

Figure 9: Timing of detection of MRSA bacteraemia in relation to presentation of patient to the reporting Trust, April 2006 to March 2007.



27% of cases were detected within 2 days of admission and a further 6% of cases were detected in patients not admitted at the time the blood specimen was taken (this patient group comprises regular attenders e.g. patients attending regularly for renal dialysis, accident and emergency patients, outpatients and day patients). It is generally considered that an MRSA bacteraemia detected within two days of presentation is unlikely to have been acquired during that healthcare admission. It is not possible to assess the percentage of community-acquired MRSA bacteraemia from these two groups of patients, as patients may have recently visited a healthcare facility prior to detection at the reporting Trust. Robust information on prior healthcare contact is currently not available.

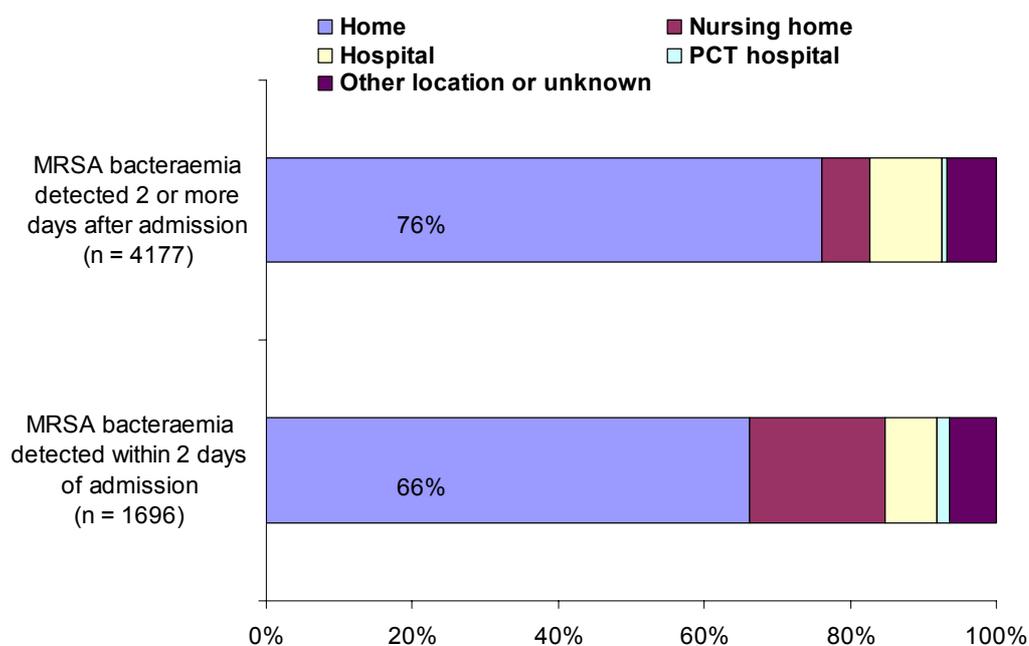
The remaining 2% of MRSA bacteraemia patients could not be categorised because of discrepant data (e.g. missing specimen date, admission date, etc.).

1.3.3.3 Patient location prior to admission

Figure 10 summarises the patient's location prior to admission to the Trust at which the MRSA bacteraemia was detected by the timing of MRSA detection. In both groups (MRSA bacteraemia detected within 2 days of admission or 2 or more days after admission), most patients were admitted from home, although this proportion was greater among patients diagnosed 2 or more days after admission.

18% of patients who were likely to have acquired their MRSA bacteraemia prior to admission were admitted from nursing homes, compared to 7% of patients whose MRSA bacteraemia was detected 2 or more days after admission.

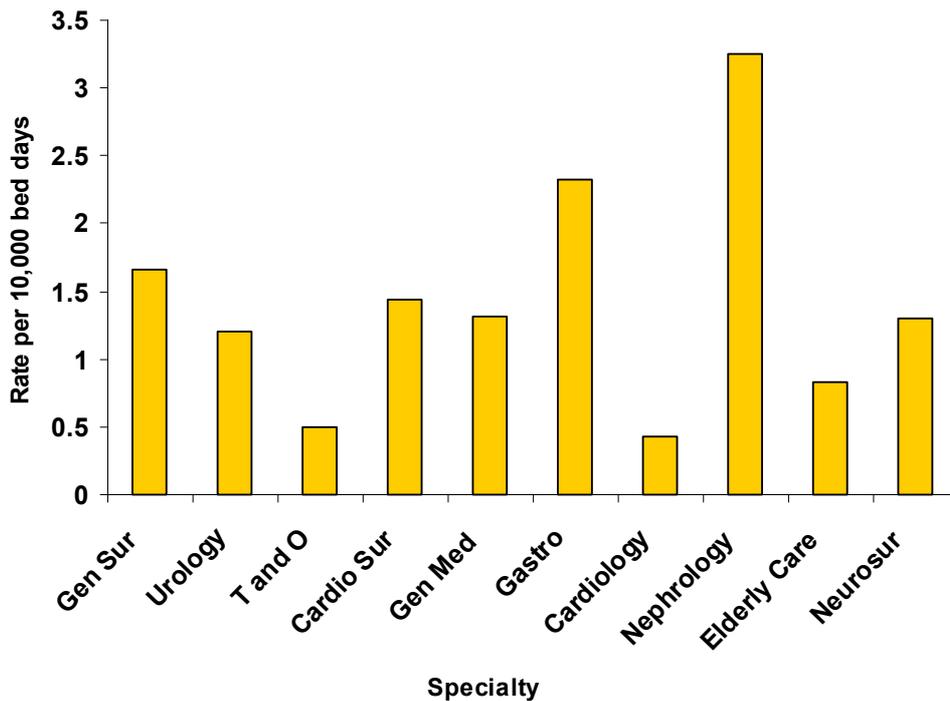
Figure 10: Patient location prior to admission, April 2006 - March 2007



1.3.3.4 MRSA bacteraemia by hospital specialty

Figure 11 shows the rate per 10,000 bed days for the ten most commonly reported specialties for MRSA bacteraemia that were likely to have been acquired during the admission (detected two or more days after admission, April 2006 to March 2007). The specialties with the highest rates were Nephrology (3.24) and Gastroenterology (2.32); specialties with the lowest rates were Trauma & Orthopaedics (0.5) and Cardiology (0.42). It is important to note that high rates are not necessarily indicative of high MRSA bacteraemia numbers; rather they demonstrate a higher proportion of MRSA bacteraemia in relation to bed days within that specialty. With regard to actual numbers of MRSA bacteraemia, levels are highest in General Medicine (1436) and General Surgery (770) – MRSA bacteraemia rates per 10,000 bed days for these specialties are lower due to the high number of admissions in these specialties.

Figure 11: MRSA bacteraemia rate (per 10,000 bed days) by specialty, March 2006 to April 2007.



Key for Figure 11

Gen Sur (General Surgery); T and O (Trauma and Orthopaedics); Cardio Sur (Cardiothoracic Surgery); Gen Med (General Medicine); Gastro (Gastroenterology); Neurosur (Neurosurgery).

1.4 Glycopeptide-Resistant Enterococcal (GRE) Bloodstream Infections

1.4.1 Introduction

Enterococci are bacteria that are commonly found in the bowels of most humans. There are many different species of enterococci, but only a few have the potential to cause infections in humans. More than 95% of infections due to enterococci are caused by just two species, *Enterococcus faecium* and *Enterococcus faecalis*. Glycopeptide-resistant enterococci (GRE) are those which are resistant to glycopeptide antibiotics (e.g. vancomycin, teicoplanin) and this resistance occurs most frequently in *E. faecium*. GRE were first detected in the United Kingdom in 1986 and have subsequently been found in many other countries. These bacteria usually behave as opportunists, causing infections in patients debilitated through other underlying conditions. When infections occur they may be difficult to treat because of limitations in the range of available antibiotics effective against these strains.

Reporting of clinically-significant GRE bacteraemia has been mandatory for NHS acute Trusts in England since September 2003. This scheme is operated by the Health Protection Agency on behalf of the Department of Health.

1.4.2 National trends

There were 903 reports of GRE bacteraemia under the mandatory scheme from acute NHS Trusts in England between October 2005 and September 2006 (Table 3). This is a 19% increase on the 758 reports received between October 2004 and September 2005 (corrected figures due to late reporting since the first report).

Table 3: GRE bacteraemia reports received under the mandatory scheme in England

Reporting year	Number of GRE bacteraemia reports
October 2003 – September 2004	628
October 2004 – September 2005	758
October 2005 – September 2006	903

One hundred and thirty one Trusts reported at least one case of GRE bacteraemia during the year, but only 20 Trusts reported more than ten cases. The majority of these (80%) were acute teaching Trusts. Forty-one Trusts reported no cases of GRE bacteraemia, a decrease on previous years. Of the six Trust categories, the largest proportion of reports (59%) is attributable to the 26 acute teaching Trusts, which is unchanged from previous year. Reports from large acute Trusts accounted for 18% of cases – slightly lower than the 22% observed the previous year.

Table 4: Number of GRE bacteraemia reports per Trust, 2006

Reporting year	Number of Trusts reporting 0, 1 to 10, or more than 10 GRE bacteraemia reports		
	0	1 to 10	More than 10
October 2003 – September 2004	75	83	14
October 2004 – September 2005	54	96	22
October 2005 – September 2006	41	111	20

1.5 Conclusions

During the 1970s, gram-negative bacteria were the most frequent source of bloodstream infections, but since then the epidemiology has been changing. An increasing proportion of bloodstream infections are associated with gram-positive bacteria or, particularly among immuno-compromised patients, fungi.

Trends in bloodstream infections

Information from the mandatory surveillance system on numbers of blood cultures taken and numbers found to be positive for micro-organisms show that there has been a significant increase in blood cultures in the five years since 2002. The increase in specimens from which pathogens were cultured has largely kept pace with the increased sampling, suggesting that the population of patients in hospitals is changing towards patients with more severe conditions, rather than changes in clinical blood taking practice. This is important context for HCAI, as an increasing population of patients with more severe clinical conditions means more patients who are particularly vulnerable to HCAI because of these underlying clinical conditions. In these circumstances, the tendency would be for more HCAI to result.

There have been larger increases in full reports on individual bloodstream infections sent by NHS laboratories to the HPA over this period, indicating increased participation by laboratories in the voluntary surveillance system.

While bloodstream infections are a common type of healthcare-associated infection, the incidence is still low among patients under 60 years. The increased frequency of bloodstream infections among the older population is likely to be due in large part by the patient's underlying disease status. As *E. coli* is now the most frequently reported pathogen isolated from bloodstream infections, further information is required to identify the proportion of these infections that are hospital-acquired and their impact on patient treatment, hospitalisation and mortality. Similarly, investigations are needed to further examine the clinical situation around CNS and *Candida* spp bloodstream infections, which have increased markedly since 2002.

Staphylococcus aureus bloodstream infections

S. aureus bacteraemia surveillance is the longest running of the mandatory surveillance schemes in England, having started in April 2001. Prior to the beginning of the mandatory surveillance scheme, reports of MRSA bacteraemia had been rising inexorably, from 68 reports in 1990 to 3895 in 2000. Mandatory surveillance brought in reports from Trusts which did not previously report under the pre-existing voluntary system and this raised the number of reports by approximately 40%. Since 2003/4 the number of reports for *S. aureus* bacteraemia and MRSA bacteraemia has dropped. While the total number of blood cultures with pathogens detected has increased by 14% in the past five years, the number of *S. aureus* bloodstream infections has decreased by 3%, suggesting that *S. aureus* is accounting for fewer bloodstream infections in England in this period.

6381 MRSA bloodstream infections were reported between April 2006 to March 2007. This marks a 12% decrease in the number of reports compared to the beginning of the mandatory surveillance scheme and a 10% decrease on the previous year. Given the increasing quality assurance around the data, the observed decrease gives grounds for optimism. The biggest impact is being seen in acute teaching hospitals, the Trust category that had most cases. However, since the mandatory scheme started in April 2001 there has been a small increase in cases

reported from small acute Trusts. Among the Health Regions, London remains the region with the highest numbers overall, but has had the most sizeable reductions. Two other regions with sizable reductions include Yorkshire and the Humber, and East England.

The new additional data collected since October 2005 adds considerably to our knowledge of MRSA epidemiology nationally. They confirm what had been suspected for a while, that a significant proportion of the bloodstream infections were likely to be present on admission. We cannot yet say whether these MRSA infections reflect acquisition previously in the same hospital, another hospital or nursing home, or community acquisition unrelated to health care. The suspicion in this country is that most of these cases are associated with healthcare activities and do not indicate true community acquisition. However, this requires further investigation. These new data also show that many bloodstream infections are detected after the patient has been in hospital for some considerable time and that some specialties, such as nephrology, contribute disproportionately to the MRSA bacteraemia burden.

Since the beginning of this mandatory surveillance much has been done to improve the quality of the data and its comparability. There is always a temptation to compare Trusts, but the caveats on the data preclude overall number comparisons. The newer categorisation of Trusts, which includes size and elements of case-mix, plus the provision of data at specialty level, enable closer comparisons than before, although cognisance should still be taken of the limitations of the data.

GRE bloodstream infections

Compared to the numbers of MRSA bloodstream infections, the numbers of GRE bloodstream infections are small. There has been an increase in the number of reports in the third year of the mandatory surveillance, observed across seven of the nine regions. The proportion of Trusts reporting a GRE bacteraemia has increased to 76% from 69% the previous year. At the Trust level, the number of GRE bacteraemia reports is affected by the case-mix i.e. the types of patients treated and specialist units within particular Trusts.

1.6 References

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2. *Clostridium difficile* infection

2.1 Introduction

Reporting of *Clostridium difficile* infection by NHS microbiology laboratories has been undertaken on a voluntary basis since 1990 as part of a system to monitor a range of infectious diseases. In order to improve the accuracy and completeness with which *Clostridium difficile* associated disease (CDAD) is monitored in England, the Department of Health introduced mandatory surveillance of CDAD in people aged 65 years and over in January 2004 as part of the healthcare-associated infection surveillance system for acute Trusts in England. Department of Health mandatory surveillance is managed by the HPA and is subject to modification as data requirements evolve for infection control or performance management purposes. From January 2004 up to March 2007 acute NHS Trusts in England were required to report total numbers of cases of CDAD in patients aged 65 years and over, wherever acquired, on a quarterly basis. Cases are defined as all diarrhoeal specimens that test positive for *C. difficile* toxin where the patient has not been diagnosed with CDAD in the preceding four weeks. The criteria for testing for infection and reporting cases were defined by the National *Clostridium difficile* Standards Group¹ and are described in Appendix 3.

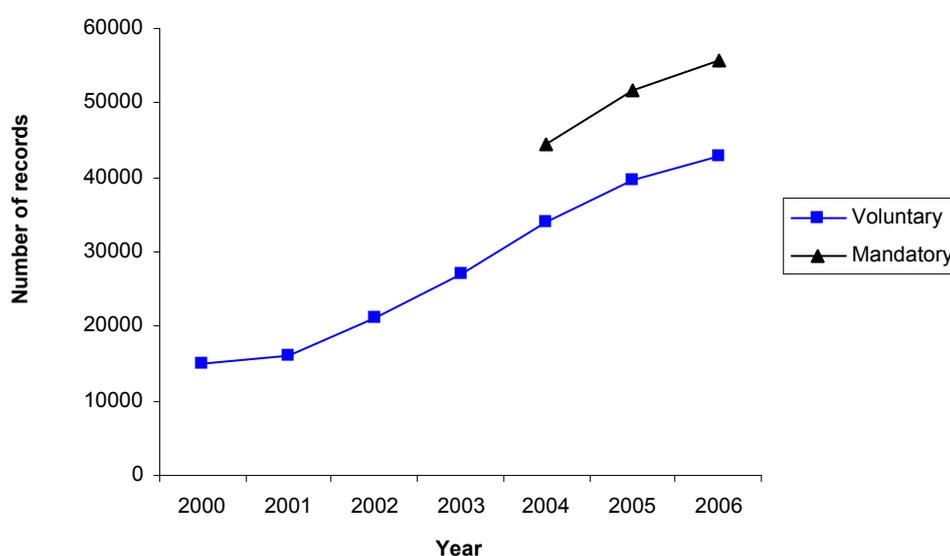
However, it is important to note that in April 2007, the Department of Health required changes to the mandatory surveillance system for CDAD to allow monitoring of progress towards meeting local targets agreed between acute NHS Trusts and their commissioning bodies, Primary Care Trusts². There was also an expansion of the dataset in April 2007 to enable more targeted control activities. This now includes information on a wider age range of affected patients, from 2 years and older. The HPA's web-enabled system for MRSA bacteraemia enhanced surveillance was redesigned to accommodate these changes.

This section describes the data collected during the third year of the mandatory surveillance scheme, January to December 2006. Some analysis of the voluntary data is also included. This enables analyses that are not possible using the mandatory data (such as age/sex analysis) and also provides an indication of how the mandating of surveillance has affected ascertainment. Future publications will include data obtained from the enhanced system established in April 2007.

2.2 National trend in *C. difficile* reports between 2000 and 2006

Prior to the implementation of *C. difficile* mandatory surveillance, data collection was made via voluntary laboratory reporting to a national database. Based on this voluntary data, the incidence of *C. difficile* associated disease in England has shown annual increases since 1990, with increases from 15,081 to 42,901 between 2000 and 2006 (Figure 12). Unlike the voluntary surveillance system, the mandatory surveillance system includes data from all 168 acute NHS Trusts in England that treat adult patients. The introduction of mandatory surveillance in 2004 has improved ascertainment by approximately 30% when compared to voluntary data for the 65 years and over age group in this same period. Numbers have continued to increase during this period, the number of mandatory reports increasing by 16% between 2004 and 2005 and 7% between 2005 and 2006 to 55,620 in 2006.

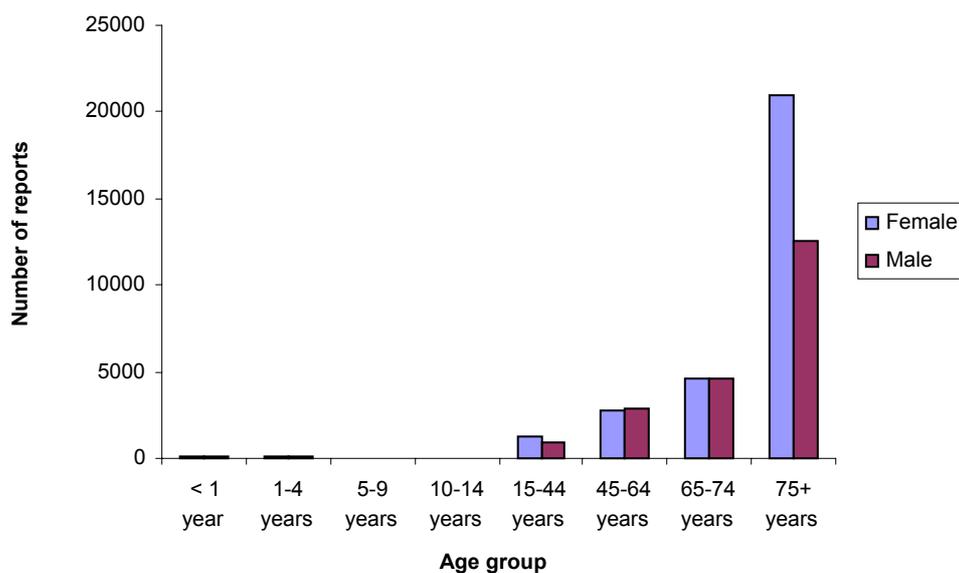
Figure 12: Trend in *C. difficile* reports for patients aged 65 years and over reported via the mandatory and voluntary reporting systems 2000 to 2006.



2.2.1 Age and sex distribution

Data from the voluntary surveillance system show that 84% of CDAD occurs in patients aged 65 and over and that markedly more females in this age group are affected than males. This finding is not totally unexpected as population statistics suggest that there are more elderly females among the general population than males. It is likely that this at least partly explains the observed sex difference. Amongst other age groups the sex difference is less pronounced, with approximately equal numbers affected (Figure 13).

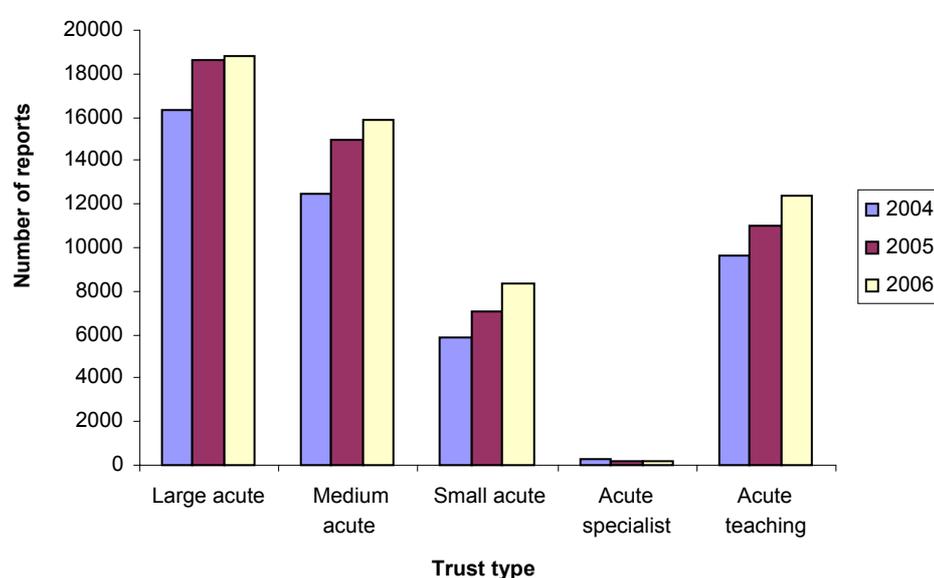
Figure 13: Age and sex distribution of *C. difficile* reports, January to December 2006 (voluntary surveillance)



2.2.2 Distribution by Trust category

The number of *C. difficile* reports received via the mandatory surveillance system has increased across all Trust categories between 2004 and 2006 (Figure 14) (see Appendix 2 for glossary of Trust categories). The largest increases between 2004 and 2005 were seen in both the medium and small acute Trusts categories (20% increase). Both these groups were also subject to increases between 2005 and 2006 (18% increase in small acute and 6% increase in medium acute). Trends seen within Trust categories appear to be generally consistent with the national picture which suggests that levels of *C. difficile* are continuing to rise (albeit at a slower rate than before).

Figure 14: Number of reports by Trust category 2004 to 2006 (mandatory surveillance)



It is important to note that the picture is slightly different when rates (per 1000 bed days) for patients aged 65 years and over are considered (Table 5). Although there remains a noticeable year-on-year increase across all Trust categories, the rate for small acute Trusts is markedly higher than the others for all years between 2004 and 2006. Large acute, medium acute and acute teaching Trusts have comparable rates in all three years. Acute specialist Trusts have the lowest rates per 1000 bed days in this period.

Table 5: Rates per 1000 bed days by Trust category 2004 to 2006 (mandatory surveillance)

	2004	2005	2006
Large acute	1.90	2.18	2.24
Medium acute	1.88	2.25	2.38
Small acute	2.07	2.50	2.85
Acute teaching	1.97	2.21	2.47
Acute specialist	0.90	0.76	0.87

2.3 Conclusions

Overall the number of cases of CDAD in people aged 65 and over increased by 7% in 2006 compared to 2005, a smaller increase than the previous year. CDAD rates were relatively similar in small acute, medium acute, large acute and acute teaching Trusts, whilst acute specialist Trusts had the lowest rates of infection. Rates were highest in small acute Trusts.

CDAD rates are influenced by many factors aside from the quality of infection prevention and control activities. At Trust level, the rate of CDAD may be affected by the type of patients treated (the “case-mix”) and the number of community-acquired cases included in a Trust’s report; for example, the number of community cases of CDAD may be higher in Trusts located in areas where there are several community hospitals or nursing homes. These and other factors mean that data, particularly rates of infection, should be interpreted with care, with consideration of some caveats (Appendix 4).

Mandatory reporting of *C. difficile* is currently undergoing a period of significant change, which could impact on future figures. 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 increased monitoring of infection.

2.4 References

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3. Surgical Site Infection Surveillance

3.1 Introduction

Surgical site infections (SSIs) are an important cause of healthcare-associated infections (HCAs). They account for 22% of all HCAI¹ and it is estimated that the delay in recovery associated with an SSI can result in additional hospital stay of 6.5 days².

It may not be possible to prevent all SSIs, but studies have shown that care provided before during and after the operation, together with the skill of the surgeon, are critical in minimising the risk that they will occur³. Surveillance provides a means of systematically monitoring the occurrence of infection and plays an important role in providing information to clinical teams to enable them to target and improve infection control practice.

The Surgical Site Infection Surveillance Service (SSISS) was established by the then Public Health Laboratory Service and the Department of Health in 1997 to enable hospitals in England to undertake surveillance of SSIs in 13 different categories of surgical procedure. In April 2004, surveillance in orthopaedic surgery became mandatory for NHS Trusts, which are required to undertake a minimum of three months surveillance each year in at least one of four categories of orthopaedic surgery. Participation in surveillance of SSI in the remaining categories has continued on a voluntary basis.

Participating hospitals are required to undertake surveillance using the methods described in a comprehensive protocol. They complete a dataset on all patients undergoing a surgical procedure in the category chosen for surveillance, and then actively monitor them during their post-operative hospital stay to identify those who develop an SSI that meets the standard case definitions.

This section of the report presents an overview of all SSISS data (for both voluntary and mandatory surveillance) collected in England between April 2006 and March 2007, and aggregated data submitted between April 2002 and March 2007. The analysis is based on all NHS hospitals and hospitals from the independent sector that have submitted data during the time periods specified. 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 that occur 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.

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:

http://www.hpa.org.uk/infections/topics_az/surgical_site_infection/default.htm

3.2 Summary of results of SSI surveillance. April 2006 to March 2007

235 hospitals contributed data on 74,702 operations and 1073 SSIs between April 2006 and March 2007 (Table 6). The four orthopaedic categories that form part of the mandatory surveillance programme accounted for the highest preponderance of reports. Rates of SSI ranged from 0.5 to 8.6 infections per 1000 post-operative days, 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.

Table 6: Rates of surgical site infection (SSI) by category of surgical procedures. Data collected between April 2006 and March 2007

Surgical category	Total no. hospitals	No. of procedures	No. SSI	Median length of stay (days)	Cumulative Incidence (per 100 operations)	Incidence Density (per 1000 post-op days)
Knee prosthesis	151	26 813	97	6	0.36	0.50
Hip prosthesis	177	27 634	189	6	0.68	0.92
Abdominal hysterectomy	14	887	7	4	0.79	1.69
ORLBF	27	3 678	69	9	1.88	1.39
Hip hemiarthroplasty	85	6 715	211	14	3.14	1.79
Vascular surgery	13	1 300	41	7.5	3.15	2.84
CABG	13	4 616	180	7	3.90	3.99
Limb amputation	10	633	46	16	7.27	4.47
Small bowel surgery	5	406	36	8	8.87	7.76
Large bowel surgery	13	2 020	197	9	9.75	8.59
Total	235	74 702	1 073			

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

3.3 Summary of 5 years of SSI surveillance. Data collected between April 2002 and March 2007

261 hospitals contributed data on 260,671 operations and 5,113 SSIs during the 5-year period between April 2002 and March 2007 (Table 7). Analyses over this longer period provide better estimates of the rates of SSI, as they are based on more data collected by a greater number of hospitals. Over this longer period rates ranged from 0.7 to 8.1 infections per 1000 post-operative days, bowel surgery accounting for the highest rates.

Table 7: Rates of surgical site infection (SSI) by category of surgical procedures - April 2002 to March 2007

Surgical category	Total no. hospitals	No. of procedures	No. SSI	Median length of stay (days)	Cumulative Incidence (per 100 operations)	Incidence Density (per 1000 post-op days)
Knee prosthesis	214	85 544	506	7	0.59	0.73
Hip prosthesis	227	89 544	1 017	7	1.14	1.30
Abdominal hysterectomy	45	6 178	74	5	1.20	2.21
ORLBF	47	12 558	249	9	1.98	1.51
Hip hemiarthroplasty	145	26 331	1 010	14	3.84	2.08
Vascular surgery	38	6 107	237	8	3.88	3.54
CABG	17	21 585	852	7	3.95	4.16
Large bowel surgery	40	9 108	807	10	8.86	7.32
Limb amputation	27	2 067	191	17	9.24	5.29
Small bowel surgery	13	1 649	170	10	10.31	8.09
Total	261	260 671	5 113			

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

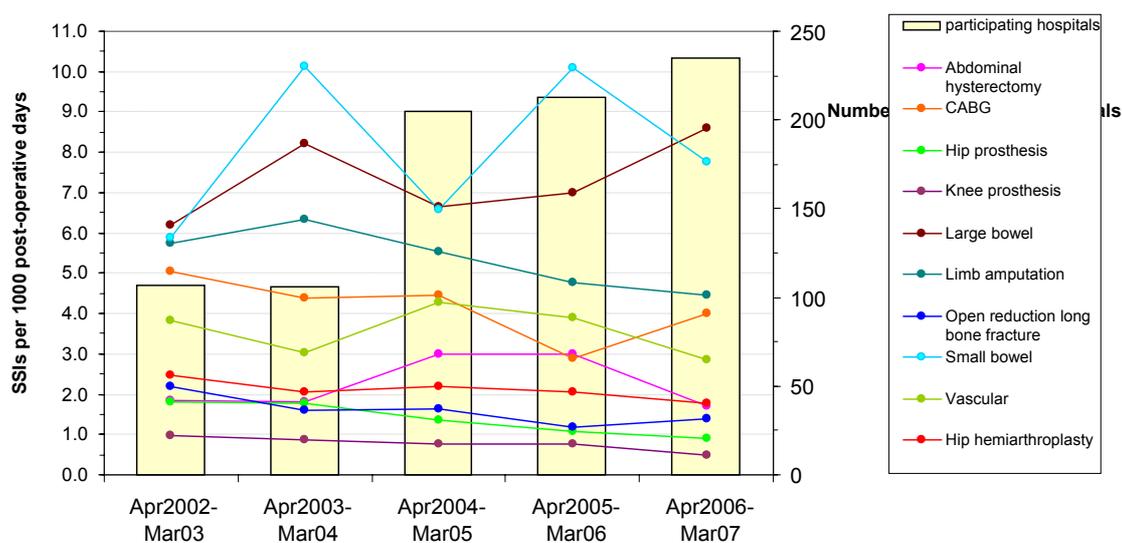
3.4 Five-year trends in incidence density of SSI by category of surgery

The yellow bars in Figure 15 represent the overall number of hospitals participating in surgical site infection surveillance. Participation was increasing prior to the introduction of mandatory surveillance. 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 15). 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 large and small bowel surgery or coronary artery bypass graft surgery, but these categories of surgery were particularly affected by fluctuations in the number of participating hospitals contributing data. However, the risk of SSI has decreased significantly ($p < 0.04$) since the mandatory surveillance of SSI in orthopaedics commenced in April 2004 in hip prosthesis, knee prosthesis and hip hemiarthroplasty.

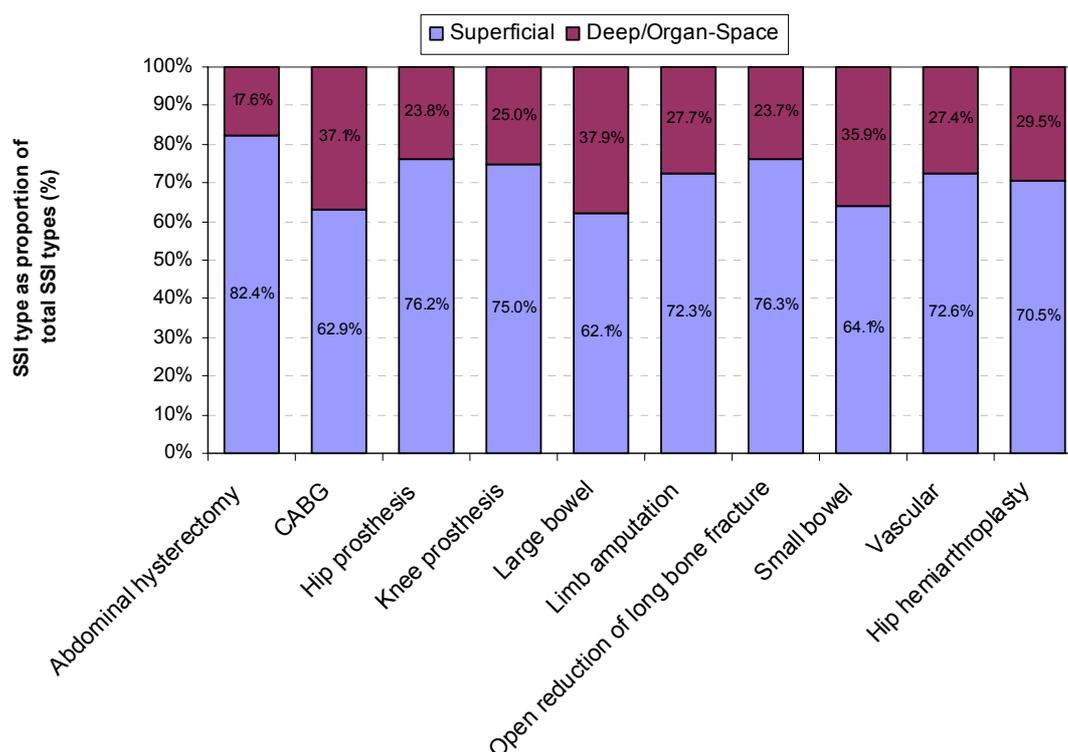
Figure 15: Trends in incidence density of SSI and number of participating hospitals by year and surgical category



3.5 Type of SSI by category of procedure. Data collected between April 2002 and March 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 16 shows that the majority of reported infections are superficial, with approximately one third of SSIs affecting the deeper tissues.

Figure 16: Proportion of total SSIs involving superficial incisions or deep/organ-space – April 2002 to March 2007



3.6 Important risk factors for SSI: risk index and age group

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 8). The risk of SSI also increases with the age of the patient. A separate analysis (not shown) indicates that in patients aged 85 years or more the risk of developing SSI is twice that of patients under 45 years (relative risk adjusted for category = 2.1; $p < 0.001$). Differences in the mix of patients and their underlying risks of developing SSI may contribute to variation in rates of SSI between hospitals.

Table 8: Incidence density of surgical site infection (SSI) by risk index. Data collected between April 2002 and March 2007.

Category of procedure	Risk Index 0		Risk Index 1		Risk Index 2 and 3	
	No. of procedures	Incidence Density (per 1000 post-op days)	No. of procedures	Incidence Density (per 1000 post-op days)	No. of procedures	Incidence Density (per 1000 post-op days)
Abdominal hysterectomy	4 302	1.82	723	4.36	73	4.54
Coronary artery bypass graft	369	3.01	12 499	3.88	1 278	5.65
Hip prosthesis	46 180	1.02	22 290	1.48	3 864	2.57
Knee prosthesis	46 596	0.52	19 719	0.98	2 203	1.55
Large bowel surgery	2 856	5.47	3 154	7.13	1 504	10.56
Limb amputation	152	3.02	637	3.89	741	6.87
Open reduction of long bone fracture	5 373	1.17	4 384	1.54	502	2.93
Small bowel surgery	230	8.11	590	5.11	450	10.43
Vascular surgery	1 064	2.21	2 537	3.64	1 314	4.91
Hip hemiarthroplasty	6 597	1.75	12 363	2.12	1 867	2.73

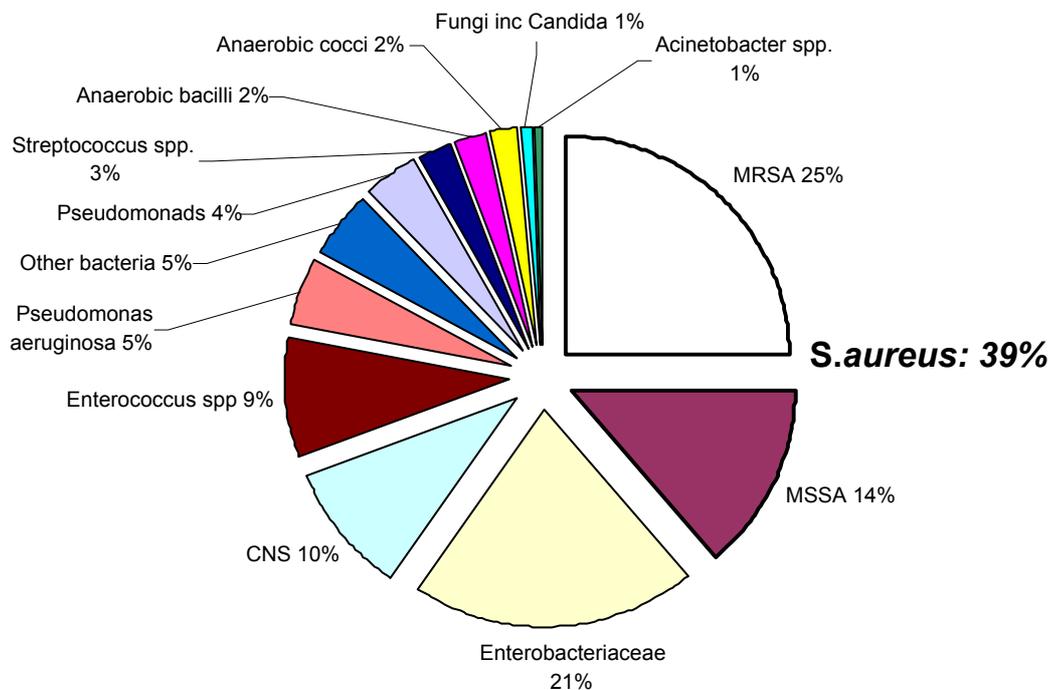
*Procedures with missing Risk Index data have not been included therefore the total number of procedures in each category may differ from those in Table 6 and Table 7.

3.7 Micro-organisms reported as causing SSI

There were 5,113 SSIs detected during the five year period between April 2002 to March 2007 across all categories of surgery combined. Causative micro-organisms were reported in 79% (4034/5113). The commonest causative micro-organism was *S.aureus*, accounting for 39% of all SSIs (Figure 17). Sixty-four percent of *S.aureus* infections were due to MRSA (1331/2081). The proportion of SSI caused by *S.aureus* was highest in hip hemiarthroplasty (41%), followed by limb amputation (40%) and open reduction of long bone fracture (35%).

Enterobacteriaceae accounted for the second biggest group of infections, accounting for 21% of all SSIs. These were a prominent cause of SSIs in three categories: coronary artery bypass graft (accounting for 32%), in large bowel surgery (accounting for 31%) and in small bowel surgery (accounting for 31%).

Figure 17: Distribution of causative micro-organisms - all surgical categories. Data collected April 2002 - March 2007.



Number of organisms = 4034

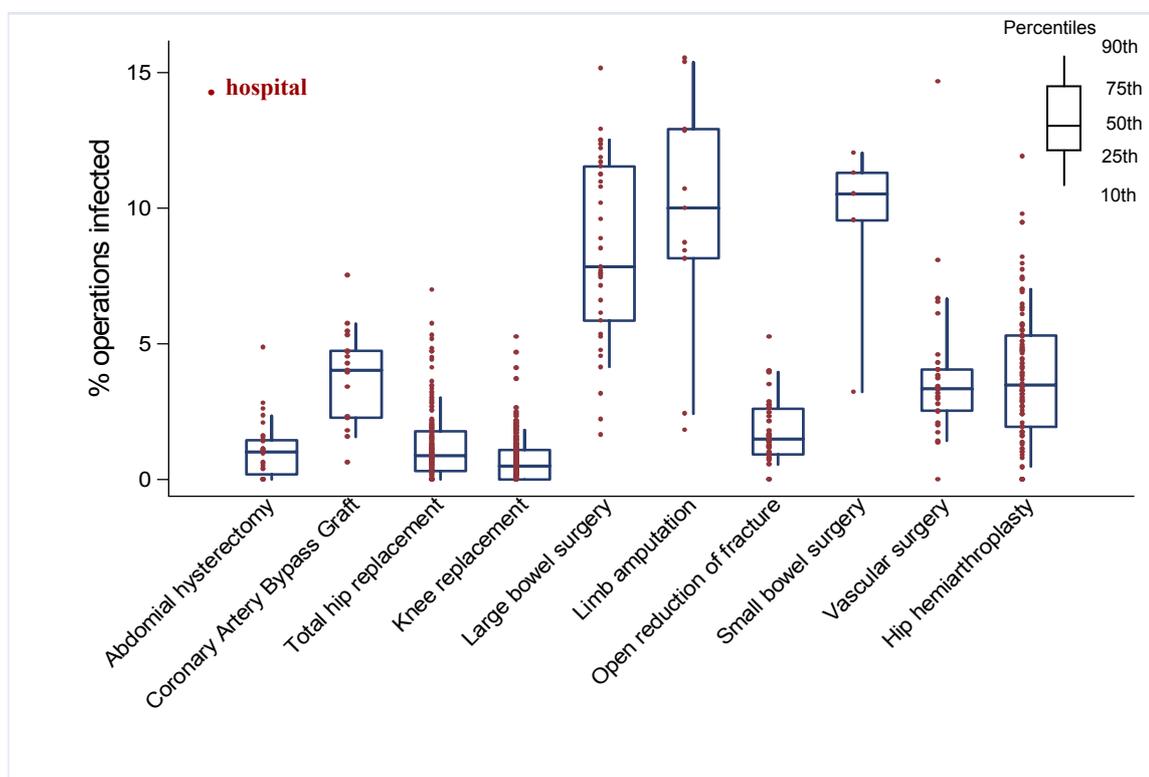
Note:

CNS: coagulase negative staphylococci
MSSA: methicillin-sensitive *S. aureus*
MRSA: methicillin-resistant *S. aureus*

3.8 Variation in rates of SSI between hospitals by category of surgical procedures. Data collected between April 2002 and March 2007.

Figure 18 shows that the rate of SSI within a category of surgical procedures varies considerably between hospitals. 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.

Figure 18: Variation in cumulative incidence rates of SSI between hospitals by category of surgical procedure - April 2002 and March 2007.



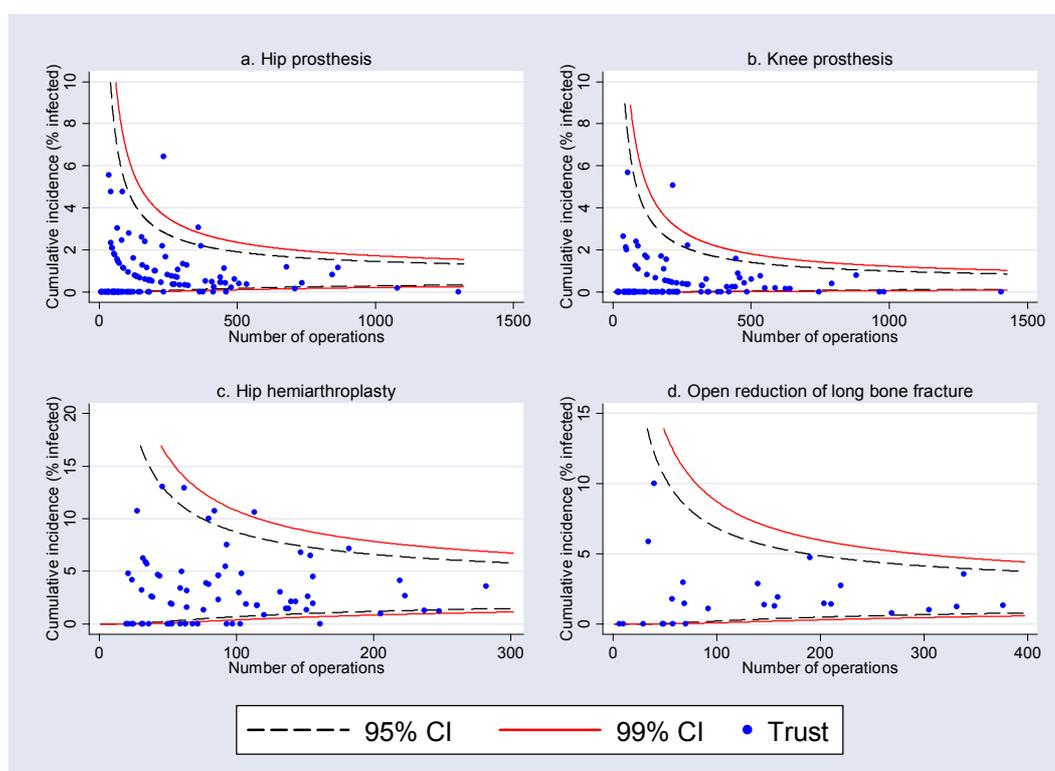
3.9 Variation in rates of SSI: Mandatory surveillance of SSI in orthopaedic surgery. April 2006 to March 2007.

The plots shown in figure 19 illustrate the total rate of SSI (cumulative incidence) at each participating Trust plotted against the number of procedures on which the rate is based. The dashed (blue) lines represent the 95% control limits (95% CL) and the solid (red) lines the 99% control limits. The probability that rates above the high 95% control limit or below the low 95% control limit have occurred by chance is low (less than 0.05%).⁴ However, these results should be interpreted with caution as no adjustment has been made for the case-mix of patients or other risk factors that may affect the rates. They should be treated as triggers for further investigation.

Only NHS facilities are included in the mandatory surveillance and the data is reported by Trust rather than hospital. 150 Trusts participated in the mandatory surveillance between April 2006 and March 2007. Overall there are eight Trusts with rates above the 95% CL. Three Trusts have rates above this limit in more than one category. Whilst these rates may be explained by patient-mix or other factors the Trusts concerned were asked to take action to investigate and address any problems identified.

A number of Trusts had rates that fell below the lower 95% control limit. In some this is likely to reflect high standards of clinical practice; however these rates may also have been influenced by a combination of other factors, such as short post-operative hospital stays and poor case ascertainment.

Figure 19: Cumulative incidence of SSI plotted against the number of operation a by Trust, April 2006 to March 2007. a) Hip prosthesis b) knee prosthesis c) hip hemiarthroplasty d) open reduction of long bone fracture



3.10 Conclusions

There has been growing participation by English hospitals in surgical site infection surveillance since April 2002, with 261 hospitals contributing data on 260,671 surgical procedures and 5,113 infections to the SSI surveillance scheme since then. This period has seen decreases in rates of SSI. Feedback of data from the surveillance scheme may be contributing to this through improvements in pre-operative practice. The strong emphasis placed on data quality enhances the value of these data as an information tool for clinical staff.

Focussing on the most recent complete year of the surveillance, April 2006 to March 2007, there were reports on 74,702 surgical procedures across 10 categories of surgery resulting in 1,073 SSIs. Not surprisingly, 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. Similarly the risk is also affected by patient factors, older patients being more at risk of developing SSI. The rate of SSI varies between hospitals, although in this report this variation has not been adjusted for the mix of patients or the number of procedures on which the rate has been based.

The majority of SSIs only 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% of *S.aureus* over the period April 2002 to March 2007). There should be active consideration of measures to prevent MRSA infections, such as pre-admission screening and separation of elective and emergency surgery patients.

The mandatory surveillance of SSI following orthopaedic surgery has identified low rates of SSI that are comparable to those reported elsewhere in Europe.⁵ In eight Trusts the rate of SSI for the period was unusually high for the period April 2006 to March 2007. These Trusts should take action to investigate their rates and address any problems identified. However, this small number of Trusts with higher rates should be set in the context of an overall decline in rates of SSI seen in the three years since the mandatory surveillance of SSI in orthopaedics commenced.

The rates of SSI reported do not include infections that only become apparent after the patient has been discharged from hospital. Since the length of post-operative stay in hospital has considerably reduced there is now an urgent need to enhance the value of SSI surveillance by developing systems that capture data on SSI that become apparent after discharge from hospital. Plans for post-discharge surveillance are being developed with the Department of Health to address concerns that rates based solely on in-patient episodes will increasingly become underestimates as lengths of admission decrease.

3.11 References

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4. Glossary of Abbreviations

AMR	Antimicrobial Resistance
ARU	Anaerobe Reference Unit
ASA	American Society of Anesthesiologists
CCU	Cardiac Care Unit or Coronary Care Unit
CDAD	<i>Clostridium difficile</i> associated disease
Cfi	Centre for Infections (at HPA)
CNS	Coagulase-negative staphylococci
DH	Department of Health
FY	Financial Year
GRE	Glycopeptide-resistant enterococci
HCAI	Healthcare-Associated Infection
HDU	High Dependency Unit
HES	Hospital Episode Statistics
HPA	Health Protection Agency
ICU	Intensive Care Unit
MRSA	Methicillin-Resistant <i>Staphylococcus aureus</i>
MSSA	Methicillin-Susceptible <i>Staphylococcus aureus</i>
NHS	National Health Service
PCR	Polymerase chain reaction
PCT	Primary Care Trust
SSI	Surgical Site Infection
SSISS	Surgical Site Infection Surveillance Service

Appendix 1: Bloodstream infections methods

Voluntary surveillance data

Data for bacterial and fungal bloodstream infections voluntarily reported by participating laboratories in England for the years 2002 to 2006 were extracted from the HPA's LabBase2 database. 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.

Mandatory blood culture and positive blood culture data

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 *Staphylococcus aureus* bacteraemia

Data from the mandatory scheme are based on reports of *S. aureus* isolated from blood cultures in English acute Trusts. These data are used to monitor trends in MRSA bacteraemia. Each of England's NHS acute Trusts contributed to the mandatory surveillance scheme for *S. aureus* in the period from April 2001 to March 2007. 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. 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 English regional boundaries introduced in April 2002.

The rate of MRSA by specialty is calculated using HES-derived patient bed-day data which are available from the Information Centre for Health and Social Care (www.ic.nhs.uk).

Mandatory GRE bacteraemia

As part of the mandatory surveillance of GRE, data are requested quarterly from each of the acute NHS Trusts in England by Health Protection Agency Local and Regional Services Division (LaRS) and 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 bacteraemia 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 bacteraemia. Trusts are asked to report all GRE bacteraemia 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.

Appendix 2: 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 Children's Trust: A Trust with restricted specialties for children.

Trust categorisation information obtained from the Information Centre.

Appendix 3: Criteria for testing and reporting for CDAD mandatory surveillance*

- Microbiology laboratories should test diarrhoeal stools for evidence of CDAD in patients aged 65 years and over (who have not been diagnosed with CDAD in the preceding four weeks). Non-diarrhoeal stools should not be tested for CDAD.
- Laboratories should test specimens for *C. difficile* toxin.
- Cases of *C. difficile* are defined as any diarrhoeal specimen that tests positive for *C. difficile* toxin, where the patient has not been diagnosed with CDAD in the preceding four weeks.
- All cases of *C. difficile* detected should be reported. The mandatory surveillance scheme does not distinguish between hospital and community-acquired cases; even cases considered to be community-acquired should be reported by the Trust in which they are detected. Cases from patients in community and Primary Care Trust (PCT) hospitals, mental health Trusts, nursing and residential homes, other NHS-run healthcare facilities and patients receiving independent healthcare should also be reported by the Trust which processes the stool sample.

Source: National *Clostridium difficile* Standards Group: Report to the Department of Health. *J Hosp Infect* 2004; 56 Suppl 1:1-38.

*It should be noted that the above criteria was used for testing prior to April 2007 when there were changes to *C. difficile* mandatory surveillance.

Appendix 4: Factors that should be taken into account when considering the *C. difficile* data

- Reporting guidelines may not have been followed consistently. The HPA is working closely with Trusts to improve adherence with the reporting guidelines and ascertainment.
- The CDAD cases reported by an acute Trust were not necessarily acquired in that Trust. In the past it was considered that *C. difficile* acquired in the community was an unusual event. Anecdotally some Trusts have reported that 18-30% of their Trust's reports were not from patients in the acute Trust. This finding requires further investigation. The distinction between hospital and community-acquired cases is difficult, not least because many patients with CDAD will have had recent hospital treatment.
- The number of CDAD reports for an acute Trust will include reports of samples sent to that acute Trust's laboratories from NHS healthcare facilities not run by an acute Trust (e.g. from PCT community hospitals, or General Practitioners). The denominator data for each acute Trust presented here however includes only the bed-days for hospitals run by that acute Trust. The bed-days listed for each acute Trust therefore frequently do not adequately represent the volume of patients served by an acute Trust's laboratories. The result is that some Trusts, in particular those that receive a large proportion of their samples from outside of their Trust, have higher rates of CDAD calculated than relates to the hospital inpatients.
- The bed occupancy figures used to derive the CDAD rates for 2006 are for patients aged 65 years and over for the period January to December 2004. This is the most recent denominator data currently available. A Trust's rate may be affected if there has been a significant change in activity that is not reflected in the bed occupancy figure for 2004. The rates published here are provisional and will be updated when the bed occupancy figures for the appropriate period are available.
- All the bed occupancy figures used to calculate the rates apply only to overnight admissions. Consequently CDAD in patients who are not admitted overnight may make a Trust's rate look falsely high, as these patients will feature in the numerator but not in the denominator.
- Specimens should be tested using toxin tests. There is some evidence that even recommended toxin tests may not detect all cases. This may have resulted in a small number of CDAD cases not being recognised.
- Reports of *C. difficile* in patients receiving independent healthcare may be included in the *C. difficile* reports from some Trusts. Further work is in progress to clarify this area of ascertainment and the extent to which these patients may have acquired their infection whilst in the community.

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