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INFECTION CONTROL IN HEALTHCARE SETTINGS

Healthcare associated infections (HCAIs) are infections transmitted to patients (and healthcare workers) as a result of healthcare procedures, in hospital and other healthcare settings. Recent years have seen an increase in the awareness of HCAIs, in particular those caused by antibiotic-resistant 'superbugs'. This POSTnote describes the nature, spread and treatment of HCAIs. It focuses on challenges for public policy in their detection, prevention and management.

What are HCAIs?

A wide variety of micro-organisms can cause HCAIs, leading to an extensive range of different diseases. Experts estimate that 9% of in-patients have an HCAI at any one time, equivalent to at least 300,000 HCAIs per year in the UK[1]. HCAIs may cause 5,000 deaths and contribute to over 15,000 deaths per year in the UK[1]. However, these are estimates based on data over 10 years old. The Department of Health (DH) has commissioned a prevalence study of HCAIs in 2005/6.

HCAIs are mostly caused by bacteria. Bacteria can exist harmlessly in people, for example on the skin or in the gut. However, some types of bacteria can cause HCAIs when they enter the body, for example through wounds and the use of surgical devices, or when the body's natural balance is disturbed. HCAIs occur in the lungs (23% of all HCAIs), urinary tract (23%), blood (6%), skin (11%) and gut. Infections are usually treated with antibiotics. However, many bacteria have developed resistance to antibiotics (Box 1). This can make infections harder to treat.

MRSA and HCAIs

The bacteria *Staphylococcus aureus* (*S. aureus*) is found on the skin or in the nose in around 30% of the

Box 1. Antibiotic resistance

Antibiotics are used to supplement the body's natural defences to a bacterial infection. They act either by killing bacteria or by stopping them growing and multiplying. Bacteria adapt to antibiotics by acquiring resistance genes. When antibiotics are present, bacteria with resistance genes survive and outgrow their relatives with no such genes. The rise in antibiotic resistant bacterial strains is due to:

- Increasing antibiotic use. The more antibiotics are being used, the more likely bacteria become resistant to them. Antibiotics are sometimes prescribed for conditions that are not treatable with antibiotics, such as colds and the 'flu. Prescription of antibiotics by GPs has fallen recently after many years of rising use.
- Patterns of antibiotic use. Many people do not finish their courses of antibiotics because they start feeling better. This means that bacteria are not killed off, so they multiply, become resistant and transmit to others.
- Using leftover antibiotics to self-medicate against a fresh infection can exacerbate the problem, as specific bacterial infections require specific antibiotics.
- The indiscriminate use of antibiotics in livestock has further compounded the problem by increasing the likelihood of resistance factors emerging.

It is more difficult to treat HCAIs caused by resistant bacteria than those caused by antibiotic-sensitive bacteria.

- Meticillin-resistant *S. aureus* (MRSA) is resistant to several antibiotics. Another form of *S. aureus*, vancomycin-resistant *S. aureus* (VRSA), is resistant to one of the most powerful, last line of defence antibiotics, vancomycin. VRSA has yet to emerge in the UK but has been detected in the US.
- *Escherichia coli* (*E. coli*) has gradually become resistant to different types of antibiotics. In 2003, the overall resistance of *E. coli* to common aminopenicillin antibiotics reached 47% across Europe[3].
- ~7% of all enterococci are resistant to vancomycin.
- *Pseudomonas aeruginosa* (*P. aeruginosa*) and Extended Spectrum Beta Lactamase (ESBL) -producing bacteria are increasingly becoming resistant to antibiotics.

population with no ill effects. *S. aureus* causes the most HCAIs attributed to blood infections (bacteraemias): 18,533 in the UK in 2004/5. Of these, the antibiotic-resistant form, MRSA (Box 1), caused 7,212. The proportion of *S.aureus* blood infections caused by MRSA has increased nearly 50-fold since 1991. Like all HCAIs, MRSA infection can be fatal: the Office of National Statistics puts the number of deaths from MRSA at 51 in 1993 and 955 in 2003[2].

Other bacteria and HCAIs

- *E. coli* is the most frequent cause of urinary HCAIs[3] and may account for around 12% of all hospital-acquired bacteraemias[4];
- *P. aeruginosa* can cause infections all over the body, but most frequently causes respiratory tract infections in very ill patients. It may account for 10% of all HCAIs[5].
- *Klebsiella pneumoniae* (*K. pneumoniae*) and glycopeptide-resistant enterococci (GRE) cause infections primarily in the lungs, urinary tract and abdomen. They are responsible for 8% and 5% of all hospital-acquired bacteraemias, respectively[4];
- *Clostridium difficile* (*C. difficile*) causes severe diarrhoea. It is transmitted through hand contact.
- ESBL-producing bacteria, which include *E. coli* and *K. pneumoniae*, are becoming far more prevalent.

Risk factors for HCAIs

For someone to be infected while they are in hospital, there has to be a source of the infective agent and a means of transmission. There are several factors that can contribute to getting an HCAI.

Therapeutic factors

The two strongest risk factors for HCAIs are the degree of underlying illness and the use of medical devices. HCAIs particularly affect high-risk patients, for example those in intensive care or receiving chemotherapy, whose immune systems are already compromised. 80% of urinary infections and over 60% of blood infections are linked to catheters or intravenous lines[6]. Contamination of surgical instruments can also cause HCAIs after an operation. The increasing use of certain new technologies and invasive procedures in recent years has increased the risk of getting an HCAI as they provide an easy way for bacteria to spread into a patient's tissues.

Hospital environment and behavioural factors

Bacteria can occur naturally on skin or in the gut or in the environment and can contaminate uniforms and medical gowns. Reservoirs of bacteria can develop, for example on dirty instruments. Unhygienic practices, such as healthcare professionals not washing hands between treating patients, can spread infections.

Organisational factors

The spread of HCAIs is also associated with:

- Bed occupancy rates. Most National Health Service (NHS) Trusts operate at above 82% bed occupancy; some hospitals have occupancy rates of over 98%. Studies have found that lower occupancy rates are associated with lower MRSA rates[1].
- The increasing movement of patients within and between hospitals is a significant factor for HCAIs.
- Nurses tend many more patients than they used to, thus potentially increasing the spread of HCAIs. The use of unregistered or poorly trained staff can compromise infection control practices.
- HCAI rates are higher in some specialist and teaching hospitals than in general hospitals because they contain more vulnerable people and carry out more complex and high-risk operations.

HCAIs: key policy issues

DH wants to reduce the number of MRSA bacteraemias by 50% by 2008 in England by raising hygiene standards and improving infection control practices. Several policy and training initiatives to tackle HCAIs have been published (Box 2). Other countries have used different measures to tackle HCAIs (Box 3).

Infection control measures

Infection control teams operate within NHS Trusts to advise on measures to tackle HCAIs. When an outbreak of infection occurs, 'fire-fighting' measures are started. Trusts also implement prevention programmes to stop HCAIs happening in the first place. However, the resources allocated to infection control vary widely and many Trusts deem their measures to be inadequate. Infection control teams usually comprise one doctor and one or more nurses per NHS Trust. Despite many new initiatives to promote infection control, no accompanying funds have been made available and there are no ring-fenced funds for NHS Trusts to allocate to infection control. Individual Trusts therefore have to decide how to fund such measures from existing budgets. Because there are 20 national targets set for the NHS, targets for infection control can also sometimes suffer.

The cost of HCAIs to the NHS is high, at around £1 billion per year[1]. Data show that significant savings, estimated at £150 million, could be achieved through the implementation of good clinical practice.

Better hygiene in healthcare settings

Probably the single most effective way of combating HCAIs is to improve hygiene in healthcare settings, in particular hand hygiene. A number of recommendations and training initiatives for improving hygiene in hospitals have been implemented since 2000 (Box 2). Hygiene practices have improved in recent years, but standards of cleanliness vary within and between hospitals and many clinicians and patients remain concerned. For example, a Healthcare Commission survey of adult in-patients in 2004 reported that over half felt that their ward was very clean, but 1 in 8 felt that bathrooms and toilets were not very clean or not clean at all[7]. A recent study of hand hygiene among first year medical students during their exams revealed only a 9% compliance rate with proper hygiene procedures[8].

Box 2. Some recent initiatives on HCAIs

Policy documents

- The National Audit Office (NAO) published 'The Management and Control of Hospital Acquired Infections in Acute NHS Trusts' (2000), which emphasised the need to tackle HCAIs.
- The Chief Medical Officer (CMO)'s report 'Getting Ahead of the Curve' (2002) highlighted antimicrobial resistance as a public health issue. It placed an emphasis on surveillance measures and included the introduction of a new Inspector of Microbiology post to oversee microbiology laboratories and standards.
- The CMO's 'Winning Ways[6] (2003) provided direction on actions necessary to reduce HCAIs, including the appointment of a Director of Infection Prevention and Control within organisations providing NHS services.
- DH's 'Towards Cleaner Hospitals and Lower Rates of Infection' (2004) included plans for a 'Matron's Charter' to create stronger cleaning teams.
- NAO's follow up report[1] (2004) noted some progress in infection control practices, but recommended further actions for the management and surveillance of HCAIs.
- The House of Commons Committee of Public Accounts published 'Improving Patient Care by Reducing the Risk of Hospital Acquired Infections: A Progress Report' (2005), urging better surveillance of HCAIs and more compliance with hygiene initiatives.

Guidelines on cleanliness and HCAI prevention

- National evidence-based 'Guidelines for Preventing Healthcare Associated Infections' (2001) outlined broad standards for good practice.
- DH published 'Infection Control in the Built Environment' (2002), guiding those responsible for the planning and design of healthcare facilities.
- The National Institute of Clinical Excellence produced guidelines on 'Infection Control: Prevention of Healthcare Associated Infection in Primary and Community Care' (2003).
- The National Patient Safety Agency launched the *clean**your**hands* campaign (2004).
- The 'NHS Healthcare Cleaning Manual' is published (2004). Designed by managers from the NHS and industry, it offers a benchmark for cleaning practices.
- The Chief Nursing Officer's 'Saving Lives' (2005) package provided practical tools and techniques to improve clinical practice.

Surveillance initiatives

- The Healthcare Associated Infection Surveillance Steering Group (HAISSG) was set up to provide DH with recommendations on HCAI surveillance needs (2000).
- DH announced the mandatory reporting of MRSA blood infection rates (2001).
- HAISSG replaced by the Health Protection Agency (HPA) Steering Group on HCAIs (2002).

Antibiotic resistance

- The Government launched its antimicrobial resistance strategy (2000), specifying eight areas for action, including on surveillance systems, prudent antimicrobial use and research into bacterial resistance.
- The House of Lords Science and Technology Select Committee report on antibiotic resistance (2001) stressed the importance of infection control teams.
- The Hospital Pharmacy Initiative promoted the prudent use of antibiotics in hospitals (2003).

Many experts argue that, even though initiatives exist for promoting hygiene, cleanliness procedures need to become more ingrained amongst healthcare professionals. Only by changing behaviours and establishing a 'culture of cleanliness' will HCAIs be tackled. Policy in this area may therefore need to focus on ensuring the implementation of hygiene initiatives, and innovative education and training programmes. The Healthcare Commission has recently started 'spot checks' of hospitals to investigate standards of cleanliness.

Box 3. Policy initiatives in other countries

HCAIs are roughly as prevalent in other countries as they are in the UK[1]. However, the UK has one of the highest rates of infection with MRSA in Europe[3].

Different countries tackle HCAIs differently. The Netherlands, for example, has very low rates of MRSA bacteraemias. In the last couple of decades, it has implemented an aggressive 'search and destroy' strategy, which involves:

- screening of all asymptomatic carriers;
- isolating patients known to be infected and 'at risk';
- cohorting of patients and personnel;
- intensive disinfection and decontamination.

This has prevented MRSA becoming endemic in The Netherlands. In the UK, similar tactics were advised. However, in the 1990s, new strains of MRSA emerged, MRSA reached epidemic proportions and isolation facilities were stretched. In light of the NHS' capabilities, such guidance was thus reconsidered.

Other countries, such as the US, Ireland and Australia, which have endemic MRSA rates, employ infection control measures similar to the UK's. Many countries, including France, Germany and Australia, operate HCAI surveillance schemes. The most mature of these is run by the Centers for Disease Control in the US.

Screening and isolating patients

Patients are not routinely screened for HCAIs when they enter hospital, although some may be screened pre-operatively. Up to 5% of patients might be carrying MRSA but it is not known what proportion of patients carrying MRSA will then go on to be infected. When an HCAI is suspected, swabs are taken and sent to the laboratory for diagnosis. If positive, isolation measures to limit the spread of an HCAI include:

- putting patients into isolation wards;
- 'nurse cohorting': physically segregating HCAI patients in one part of a ward, with nursing by designated staff;
- putting cohorts of patients on general wards (without designated nursing staff);
- use of single-bedded rooms;
- healthcare workers using barrier precautions (gowns, gloves, masks) as physical barriers to transmission.

However, a recent systematic review of all studies assessing the effectiveness of isolation measures against MRSA found major methodological weaknesses in published research[9]. It concluded that no study has been able to assess the effectiveness of isolation measures alone for tackling MRSA infection. Nonetheless, it recommended that, in the absence of such research, hospitals should continue to use isolation measures to deal with MRSA.

Diagnosing MRSA and HCAIs

Current methods for diagnosing MRSA infection take 48–72 hours. The advent of molecular methods is likely to decrease this time significantly. However, some experts argue that decreasing the diagnosis time will put increased strain on isolation measures. There is debate over whether it is more useful to diagnose MRSA when it is at the colonisation stage (existing benignly on skin, for example) or the infection stage. Diagnosis at the colonisation stage may make it easier to anticipate isolation measures.

More widely, when a patient's sample is sent for diagnosis, different laboratories use different methods for detecting HCAIs. This means that what might be reported as an HCAI by one laboratory might not be reported as such by another. Experts are calling for regulation to be introduced, recommending the use of certain tests over others. Problems associated with the diagnosis of HCAIs can compound issues associated with surveillance.

Surveillance of HCAIs

The HPA introduced mandatory surveillance of MRSA blood infections in 2001. Mandatory surveillance of GRE and *C. difficile* started in 2003 and 2004, respectively. Many hospitals also continue to use the voluntary Nosocomial[10] Infection National Surveillance Scheme (NINSS) established in 1996. NINSS is a voluntary scheme, using standard surveillance methods in hospitals in England to provide information on HCAIs.

However, there still exists no national mandatory surveillance scheme for all HCAIs. The different surveillance streams that do exist do not present comparable data. The lack of information technology in some Trusts also means that surveillance cannot be carried out. Therefore, the overall extent of HCAIs remains difficult to gauge. The Committee of Public Accounts has twice recommended that a national HCAI surveillance scheme, perhaps NINSS itself, should be made mandatory. In response, DH has commissioned a national survey of all HCAIs, due in September 2006.

Estimates of the number of deaths caused by HCAIs vary widely as it is often difficult to tell whether HCAIs are the primary cause of death or a contributory factor. The HPA is currently performing an audit of HCAI reporting on death certificates. Some experts are calling for clearer guidelines for mentioning HCAIs on death certificates.

Research into HCAIs and antibiotic resistance

Relatively little evidence-based research has been conducted into the best ways to deal with HCAIs or to lower their incidence, yet such research is urgently needed. DH's 'Winning Ways[6] provides £3 million for such research, of which £1 million has been made available for competitive projects. Some argue, however, that this is not enough, as it is estimated that research to produce guidelines costs around £0.5 million alone.

DH operates a 'rapid review panel' designed to fast-track promising innovative procedures through research, and, if successful into approved use in the NHS. Silver-coated catheters, proven to cut infection rates as compared to traditional catheters, were assessed this way.

Research into the mechanisms of antibiotic resistance is progressing. However, there is limited hope for the development of new antibiotics. Such work is hugely expensive. Although basic research can be funded through the public sector, subsequent development relies heavily on the pharmaceutical industry. Yet, if a successful new antibiotic were to be discovered and manufactured, it is likely that doctors would only use it as a last line of defence because of fear of resistance developing. Thus, pharmaceutical companies would face a long delay in recouping their costs.

Overview

- More patients needing more complex operations means that HCAIs occur more often.
- *S. aureus* is the most common cause of hospital-acquired blood infections, but other organisms can cause potentially fatal HCAIs.
- HCAIs are treatable with antibiotics, but those caused by resistant bacteria are more difficult to treat.
- It is unlikely that HCAIs will ever be completely eradicated but they can be more effectively dealt with.
- Hygiene initiatives have been effective in tackling HCAIs, but a 'culture of cleanliness' needs to become more ingrained amongst healthcare workers. Experts suggest that 15–30% of HCAIs could be prevented by better application of good practice.
- There are no ring-fenced funds for infection control measures; resource allocation varies between Trusts.
- Many argue that measures for the surveillance of all HCAIs, not just specific infections, need urgent improvement.
- The standardisation of diagnostic tests and procedures may help tackle HCAIs.
- Research into HCAIs and antibiotic resistance may help in the fight against HCAIs. There is limited hope for the development of new antibiotics.

Endnotes

1 Improving Patient Care by Reducing the Risk of Hospital Acquired Infection: A Progress Report, National Audit Office 2004
2 www.statistics.gov.uk/cci/nugget.asp?id=1067
3 www.earss.rivm.nl/
4 www.hpa.org.uk/infections/publications/ninns/hosacq_HAB_2002.pdf
5 www.hpa.org.uk/srmd/div_nsi_lhcai/factsheet_pseudomonads.htm
6 Winning Ways, Department of Health 2003
7 Patient Survey Report, Healthcare Commission 2004
8 Hunt DC et al. *J Hosp Infect.* 2005, 59, 371
9 Cooper BS et al. *BMJ* 2004, 329, 533
10 A nosocomial infection is a hospital-acquired infection.

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POST is grateful to all contributors and reviewers. For further information on this subject, please contact the author, Dr Bella Starling, at POST.

The Parliamentary Office of Science and Technology, 7 Millbank, London SW1P 3JA; Tel: 020 7219 2840; email: post@parliament.uk

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