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MRSA: why have we got it and can we do anything about it?

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Abstract

MRSA, first identified in 1960, became a major cause of healthcare-associated infection with the emergence of epidemic strains EMRSA 15 and 16 in the 1990s. MRSA bacteraemia surveillance in England showed a peak of 7700 in 2003–2004. A target was set to halve MRSA bacteraemias by 2008 backed by a central improvement programme for infection prevention and control. Healthcare-associated infection is a patient safety issue with joint responsibility between: clinicians responsible for patient care; managers responsible for the organisation of services; and the government/ Department of Health responsible for national strategy, prioritisation and performance management, together with introducing a statutory Code of Practice. By 2011, the number of MRSA bacteraemias had reduced by 80% to 1481. The key drivers of improvement were management responsibility, enhanced surveillance, adherence to clinical protocols and care bundles for invasive procedures, hand hygiene and environmental cleaning, and improved isolation procedures and antibiotic stewardship. The target has been translated into an ongoing MRSA objective, and further control of MRSA is supported by a screening programme aimed at all relevant hospital admissions. Sustaining the reduction will depend upon joint responsibility between management maintaining compliance assurance with policies and individual clinicians keeping it as a priority in patient safety.
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What is MRSA?

MRSA stands for meticillin (formerly methicillin)-resistant *Staphylococcus aureus* and has had a major impact on healthcare activities in the United Kingdom and elsewhere over the past two decades. *S. aureus* was discovered to be a major cause of postoperative wound sepsis and other infections by the Scottish surgeon Ogston in the 1880s. It remains the most common cause of wound infections (accidental and surgical) and a leading cause of healthcare-associated infections (HCAI). When penicillin was introduced in the early 1940s, almost all *S. aureus* strains were susceptible to it and, therefore, it was widely used. In the 1950s there were serious hospital outbreaks of infection caused by the type 80/81 strain and by the end of that decade, 95% of strains were resistant to penicillin due to natural selection of penicillinase (β-lactamase)-producing strains. Meticillin, and later oxacillin, cloxacillin and flucloxacillin, was developed to resist breakdown by β-lactamase and restore treatment options. Within a year of its introduction in 1960, the first MRSA strain was described.

The normal habitat of all staphylococci is the skin, in particular the anterior nares and the warm, moist skin folds of the perineum (and groin), and axilla, together with the throat. Everyone carries *Staphylococcus epidermidis* as part of their normal flora and this is harmless, except in very susceptible patients, but can cause confusion because it is often meticillin resistant. At any one time, about 30% of people are colonised with *S. aureus* and are known as 'carriers'. The nose is the principal carriage site in most carriers, with other skin sites colonised to a variable extent. In $<10\%$ of carriers, the *S. aureus* is MRSA, that is, a colonisation rate of ca 2% of the total population. Like all *S. aureus*, MRSA is a non-sporing bacterium that survives on the skin and also in dust and on environmental surfaces. However, it is removed by washing with soap and water, and is killed by disinfectants, including alcohol hand rubs. Although it is resistant to penicillins and cephalosporins, it remains sensitive generally to the glycopeptide antibiotics and to some newer

agents such as linezolid. The infections caused by *S. aureus*, including MRSA, are postoperative and accidental wounds, intravenous line infections, chronic skin ulcers, and deep abscesses and pneumonia, particularly in hospitalised patients requiring critical care. Bacteraemia (bloodstream infections) may result from any of these types of infection.

MRSA infections were interesting rarities in the 1960s and caused some occasional clinical concerns in the 1970s. In the 1980s, some MRSA strains (now called epidemic strains; EMRSA) caused isolated and restricted outbreaks of HCAI, which were mostly contained by a 'search and destroy' approach (ie, isolate and treat the patient; screen all contacts among patients and staff for colonisation; give decolonisation treatment to any found to be positive). However, in the early 1990s in the United Kingdom, two EMRSA strains, 15 and 16, emerged with greater capacity to spread in healthcare settings and to cause a higher proportion of severe disease. Their spread through the NHS was not controlled and they became a major HCAI problem and the subject of media publicity, patient group campaigns, and political concern in the early years of this century. Sadly, the 'search and destroy' approach had been abandoned in many places. Infections with these strains were difficult to treat and caused significant morbidity and mortality.

The millennium challenge

The extent of the MRSA epidemic was monitored by surveillance of *S. aureus* bacteraemia cases, as these represented the most severe end of the spectrum of infection and had the clearest and most reliable diagnosis (blood should be sterile, therefore a positive blood culture is a very significant finding). The surveillance was undertaken initially by the Public Health Laboratory Service and then, in 2003, by the Health Protection Agency (HPA). By the early 2000s, more than 7000 cases of MRSA bacteraemia were being reported each year in England, with similar problems in the other UK countries. Media headlines were talking about MRSA massacres, plagues, super bugs, and squalid hospitals.

During the 1990s, when MRSA bacteraemia cases started to rise, many had assumed that they were replacing infections caused by sensitive *S. aureus* strains. However, it is now clear that the MRSA cases were in addition to those caused by sensitive strains, which were themselves also increasing. In 2003–2004, the MRSA bacteraemia figures peaked at 7700 cases in England, and HCAI became a major priority for the government and the NHS.

Why had this situation developed? There is a strong argument that during the last quarter of the twentieth century, infections (including HCAI) had not been regarded as important parts of modern medical practice. Antibiotics and vaccines were thought to provide the answer to infection and clinical hygiene; asepsis and other aspects of infection prevention and control did not have their former position in the training of doctors and nurses. Medicine was making tremendous progress in increasing life expectancy and in the treatment of cancer, cardiovascular disease, and a range of chronic illnesses. These created an increasing population of vulnerable patients at risk of infection but infection was regarded as an incidental nuisance rather than a major risk to a patient's health. Infection prevention and control was left to the infection specialists who had plenty of interesting work to do but a generally low profile.

The publicity given to MRSA created a range of popular myths that became difficult to dispel. It was said to be a new threat that had never been seen before and was only a problem in the United Kingdom—neither of which was true. It was said to be responsible for all HCAI and all deaths from HCAI, which ignored infections caused by resistant Gram-negative bacteria and challenges such as *Clostridium difficile* infection. It was suggested that MRSA infection was a death sentence, or would at least result in severe disability, and that those who were colonised with MRSA were a threat to everyone else (other patients, clinical staff, and their contacts in the population at large), which resulted in unfounded ostracism of people within their own families and communities—again, wrong and unnecessary. It was also said to be untreatable by antibiotics and resistant to disinfectants, neither of which was true. It was also claimed that it could spread through the air simply by a colonised person breathing and that, as a result, it was everywhere in the environment, particularly in hospitals. The latter was fuelled by some undercover sampling using inadequate microbiological methods that gave wrong results, but all added to the tabloid hysteria.

The response targets and programmes

The response from government and the Department of Health was 'something must be done': a target was set to halve MRSA infections (ie, bacteraemias) by 2008, and a programme was established to improve infection prevention and control practice throughout the NHS.[1] Responsibility for controlling MRSA and other causes of HCAI is a shared responsibility among all who have a role in the delivery of health and social care. Clinicians (doctors, nurses, and other professional colleagues) have a personal and professional responsibility for the safe care of their patients. This includes minimising the risk of infection by implementing best clinical practice protocols, antibiotic stewardship, and so on. Health and social care managers and overseeing boards are

responsible for providing the corporate environment in which infection prevention and control has a high priority. Third, the government and Department of Health/NHS national managers are responsible for making HCAI prevention and control a top priority throughout health and social care services, and holding local managers and boards to account for delivering a quality service with low rates of HCAI.[2] In England, the government responsibility was backed by legislation in the Health Act 2006,[3] which implemented a statutory Code of Practice on HCAI that applied to all NHS bodies, and the Health and Social Care Act 2008,[4] which extended the Code to all care settings in the independent sector and the NHS. Registration of all health and social care organisations with the Care Quality Commission requires compliance with the code.

Where are we now?

In the three years of the target programme (2005–2008), mandatory surveillance of MRSA bacteraemia showed a fall of 62% from the 2003–2004 baseline of 7700 to 2932 in 2008–2009. The reduction continued to 1898 in 2009–2010 (75% reduction) and 1481 in 2010–2011 (81% reduction).[5] There has also been a change in pattern of MRSA bacteraemia underlying causes and a shift in the balance between cases resulting from hospital care and those associated with the wider parts of the healthcare system. By 2010, slightly more cases were associated with non-hospital care. One of the main reasons for this change has been the emphasis on preventing cases associated with intravascular lines and other implanted devices. These accounted for more than half of the cases in hospital practice with another 20% related to skin and soft tissues infection. In the wider community, $<30\%$ are associated with implanted or indwelling devices and the same number are linked to skin and soft tissue infections.

As well as the reduction in bacteraemia cases, the number of deaths in which MRSA was shown on the death certificate has fallen from 1556 (480 as underlying cause) in 2006 to 718 (133 as underlying cause) in 2009 in England.[6]

What are the next steps?

The MRSA target has been replaced by an ongoing objective to maintain the impetus for reducing the number of cases. The objective applies to all acute trusts and primary care trusts and requires all to get their MRSA rates to meet the current median levels. Those that are already below the median have to reduce to the best performing quartile or by at least 20%. Also, a programme for screening patients admitted to NHS hospitals so that those found to be colonised can be isolated and given suppressive decolonisation treatment was introduced in 2009. All relevant elective admissions were being screened by March 2009 and all relevant acute admissions by the end of 2010. The reason behind the screening programme is that colonisation generally precedes infection and a colonised patient is at risk of developing an infection themselves and a possible source of transmission to others. If they can be identified, isolated (where possible) and treated, this reduces the risk to the individual and the risk of transmission to others. The aim of the screening programme is to reduce the incidence of MRSA infections overall. It should help continue the reduction in bacteraemia numbers, and also to reduce the number of cases of wound infection, skin and soft tissue infection, ventilator pneumonia, and urinary tract (catheter associated) infection caused by MRSA.

How has MRSA infection been controlled so far?

There is no single 'silver bullet' to solve the challenge of MRSA infection. Infection prevention and control requires a combination of actions and activities across the whole of a healthcare organisation. Senior managers have ensured that infection prevention and control is a major priority embedded across their organisations. They monitor surveillance and audit data at all levels 'from board to ward' and ensure that all staff perform their part. The local and national programmes are supported by accurate and timely surveillance data from the HPA and by the production of local surveillance data for all wards, clinics, and units within an organisation. The essential nature of surveillance is encapsulated in the dictum 'you have to measure it to manage it' and this applies at every level.

At the heart of delivering lower rates of MRSA infection has been the implementation of much improved clinical practice. This includes the emphasis on hand hygiene (hand washing and the use of alcohol hand rubs),[7] improved environmental cleaning and disinfection to help cut that route of infection transmission, and the implementation of care bundles for the key clinical activities that carry a high risk of infection. The aim of the care bundles, or high impact interventions, was to set out in a simple bullet-point format the five or six essential elements needed to minimise the infection risk associated with invasive procedures. All of the elements should be performed correctly on every occasion and the bundles incorporate a simple audit tool for self- or peer-assessment on a regular basis. For MRSA infection, the bundles focused on central venous catheters and peripheral venous cannulae, renal dialysis catheters, the care of surgical

sites (wounds), care of ventilated patients, and the management of urinary catheters.[8,9] All of this has helped to embed a zero tolerance approach to MRSA and other HACI across the NHS. This does not mean 'there will be no infections'—that would be biologically implausible. But the risk of infection can be minimised and there should be no tolerance of preventable (avoidable) infections or of poor clinical practice whether it be in hand hygiene compliance, the application of aseptic procedures, or imprudent antibiotic prescribing. Clinical staff can be expected to do these things properly every time.

It is now clear that the focus needs to be on the control of MRSA across the whole health and social care community. This will require acute trusts, and primary and community care organisations to work in partnership to identify those colonised with MRSA and those at risk of infection and take appropriate preventive measures. This will include implementation of good antibiotic stewardship to minimise the selective pressure for these resistant organisms. Antibiotics are life-saving magic bullets that are essential for modern medical practice but they are a finite resource. Resistance is a Darwinian certainty and it can have very damaging consequences for patients infected with resistant organisms. New antibiotics are needed, but research and development takes time and is expensive, and conservation and prudent use of current agents remain priorities. The Code of Practice requires all organisations to have systems in place for the management and implementation of antimicrobial stewardship, together with policies, protocols, and training in good prescribing practice, as well as in all other aspects of infection prevention and control.

Challenge for the future

Sustaining the MRSA bacteraemia reductions, and reducing other HCAI problems, will continue to demand a combination of management and personal responsibility. Managers will need assurance that their organisation is complying with all the requirements for infection prevention and control, and delivering a quality service from board to ward. They need timely surveillance data coupled with the audit results of hand hygiene, clinical protocols, isolation protocols, antibiotic prescribing, and cleanliness inspections—reviewed at all management levels. The personal responsibility applies to all professionals in health care. Infection prevention and control needs to be part of everyone's job description and job plan; mandatory training in infection prevention and control, and inclusion in continued professional development plans needs to continue and this should be liked to appraisal and individual performance review. Disciplinary measures must be a last resort but may occasionally have to be implemented. Infection needs to be kept as a patient safety priority throughout healthcare because it will never go away. The services of the future will have to ensure that they do not repeat the mistakes of the past 30 years.

Conflict of interest

The author declares no conflict of interest.

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