

# The costs and benefits of hospital MRSA screening

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## ABSTRACT

Methicillin-resistant *Staphylococcus aureus* (MRSA) infections represent a significant challenge. Rapid and accurate identification of MRSA in hospital admissions is essential for timely treatment decisions, isolation/bio-burden reduction and reducing potential cross-transmission/acquisition of these infections. Here we present the clinical benefits and cost-effectiveness of a rapid MRSA screening programme, which was implemented at Blackpool Victoria Hospital. The economic advantages of continuing the service despite a 15% cut in overall budget are also presented. In the pre-study period (2007–2008) 20461 emergency and 21461 elective admissions were screened and 40 cases of MRSA bacteraemia were reported. Glycopeptide unit days were 4145. During the 12-month pilot, approximately 4% of the PCR emergency screens were positive. Nine MRSA bacteraemias were reported during this period, representing a 78% reduction over the previous year. The cost of service over 12 months was £396 285. Estimated savings from the reduction in bed days and glycopeptide use ranged from 282 266 to 329 117. Hospital-acquired (post 48 hours) MRSA bacteraemias were reduced from 28 to 5. Annual glycopeptide spend was reduced by 50%, from £251 168 (2007–2008) to £124 060 (2008–2009). Rapidly available MRSA results were used to complement clinical decision making and optimize treatment. The cost-effectiveness of any screening programme is proportional to its success. The overall benefits and savings achieved in the current study more than justified the expenditure on rapid screening, and the Trust has since adopted PCR as a regular screening service for emergency admissions.

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Nosocomial infections caused by methicillin-resistant *Staphylococcus aureus* (MRSA) are frequently associated with treatment failure, prolonged subsequent treatment and/or hospitalization and additional costs (Carroll, 2008). The severity of MRSA infections ranges from localized skin and soft tissue infections to life-threatening infections, such as bacteraemia and endocarditis. The risk of invasive MRSA infections increases with age and pre-existing co-morbidities (Nathwani et al, 2008). In many parts of the world (including Europe, the Americas, North Africa, the Middle East and East Asia), MRSA is the most commonly isolated antibiotic-resistant pathogen (Grundmann et al, 2006). Although international comparisons are difficult because of the differences in testing and surveillance systems, it has been estimated that

of the 2 billion individuals carrying *S. aureus*, between 2 and 53 million individuals carry MRSA globally (Grundmann et al, 2006). In the UK, recent studies report a MRSA colonization rate of 6–14% of patients admitted to hospital (Karas et al, 2009, Bamra et al, 2009). One third of patients colonized with MRSA will go on to develop an infection (Coia et al, 2006). These data, and the fact that many cases of MRSA occur within 72 hours of admission, highlight the fact that screening of emergency admissions may play an important role in reducing the overall number of MRSA infections in any institution.

## The impact of screening

In 2008, the Department of Health (DoH) issued guidance recommending screening on admission of all elective patients by the end of

March 2009, and of all emergency patients by the end of 2010 (DoH, 2008). In March 2010, the DoH issued additional guidance for Chief Executives and Directors of Performance to refresh and re-publish their MRSA screening policy and statement of compliance by 31 December 2010, along with the introduction of universal screening of all relevant emergency admissions (DoH, 2010). To date, the Health Technology Assessment (HTA) programme has only published on the effect of different isolation policies for patients diagnosed with MRSA (Cooper et al, 2003). One of the conclusions of the HTA 2003 review was that 'intensive concerted interventions that include isolation can substantially reduce MRSA', but the effect of targeted or universal screening was outside the scope of this early review. A number of previous international publications have attempted to assess the benefits of mandatory screening, but have reported conflicting results (Hardy et al, 2007; Harbarth et al, 2008; Jeyaratnam et al, 2008; McGinagle et al, 2008; Robicsek et al, 2008). The differences in the findings of these studies may relate to the background prevalence of MRSA, national and local differences in hospital practice, management, and the different testing methodologies employed for detection.

### Investigating the feasibility

As yet it is too early to assess the impact of the introduction of mandatory screening for all elective admissions in the UK. In addition, patients being admitted to hospitals are increasingly concerned about the 'risk' of acquiring a 'superbug' such as MRSA, increasing the levels of anxiety at a potentially stressful time (Jolley, 2008). Screening combined with rapid reporting of results provides reassurance to allay the concerns of patients about acquiring an MRSA-associated infection. It was for these reasons that the current study was initiated

— to investigate the feasibility, cost and effect of adopting a universal screening programme (which includes polymerase chain reaction (PCR)) in a large district general hospital.

### Background to the study

The current study was conducted to investigate the impact of a 12-month pilot project, which introduced PCR testing with BD GeneOhm MRSA PCR™ (Becton Dickinson, Oxford, UK) for MRSA screening of all emergency admissions (medical and surgical) and critical care patients to a large district hospital in the UK. Known MRSA positives were not screened by PCR. GeneOhm MRSA was selected over other rapid manual molecular tests because of the 'rapid' time to result (<2 hours) that can be achieved over culture methods (Malhotra-Kumar et al, 2008). GeneOhm MRSA also has a sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of 91%, 96%, 75% and 99%, respectively (Kerremans et al, 2008).

Blackpool Victoria Hospital is a large district general hospital including acute medical, surgical, elderly care, women's services and intensive care wards, specialist cardiac and haematology centres with 830 beds and 11 operating theatres ([www.bfwh.nhs.uk](http://www.bfwh.nhs.uk)). The hospital covers a population of 330 000 residents and 12 million holidaymakers who visit the area annually. During the financial year April 2007 to March 2008, 299 957 patients were treated in the hospital as inpatients and there were 54 423 day cases. The average total bed occupancy for this period was 84%. In the following financial year (2008–2009), 305 116 patients were admitted, there were 57 158 day cases, with an average bed occupancy of 90%. This increase in the numbers of patients treated in the hospital strengthened the need to improve the timeliness of microbiological reporting, to alleviate the increasing pressures in the hospital.

**Table 1. MRSA isolates by specimen type**

	Bacteraemia blood culture	Wounds	Other	Respiratory (including sputum, bronchial washing)	Urinary	Total MRSA from all specimens
April 07–March 08	40	628	74	114	26	883
April 08–March 09	9	485	71	76	31	672
April 09–March 10	8	382	62	39	10	451

The study was conducted in conjunction with a revision of the hospital MRSA guidelines, a comprehensive MRSA containment strategy and training and awareness initiatives.

### Objectives

The primary objective of the study was to investigate whether rapid screening results would have an impact on reducing the number of MRSA bacteraemias. Secondary objectives were to investigate whether the introduction of rapid screening for MRSA had a positive effect on overall costs within the hospital, and whether more rapid reporting would reduce the use of glycopeptides.

### Methods

#### Pre-study period

The pre-study period (April 2007 to March 2008) was used for planning and preparation.

During the pre-study period, MRSA screening of elective and emergency targeted high-risk admissions was conducted using the culture-based CHROMagar method. Data from the laboratory were recorded on an Excel spreadsheet. A retrospective analysis of all MRSA infections and antibiotic consumption was also conducted.

#### Twelve-month pilot

Between April 2008 and March 2009 all emergency admissions (except known MRSA positives) admitted to medicine and surgery through the A&E and critical care departments (except known positives) or clinical decision unit were screened using a rapid molecular PCR test (GeneOhm MRSA) for the detection

of MRSA from nasal swabs. Elective admissions continued to be screened using the chromogenic culture-based method. Microbiology Laboratory offered PCR runs on a seven-day-a-week basis, between 8am and 12am. Total turnaround time was recorded, from swab to communication of results. Bacteraemia data was obtained from the DoH dataset and wound data were obtained from the pathology database. Vertical audits were conducted to analyse data and feedback collated. Any delays in action on results were recorded and communicated to the infection control and nursing teams. Data on MRSA bacteraemias and antibiotic use were recorded by a university student on a temporary summer placement.

Colonization rate was defined as: MRSA carriage/10 000 patient bed-days (the proportion of patients found to be carriers out of total number of screens). Root Cause Analysis (using a standard tool) was conducted for all MRSA bacteraemias. The costs of rapid testing were calculated as: staff salaries, equipment and consumables. Costs of MRSA bacteraemias were calculated from the DoH's *Socio-economic Burden of Hospital Acquired Infections* range of £5 397 and £7 026 adjusted to 2008 prices of £6 746 and £8 783 (total inflation rate 25%) (Plowman et al, 1999).

### Results

#### Pre-study period

Over the pre-study period, six-month bed-days and day cases varied between 148 093 and 27 323 from April to September 2007 respectively, and between 151 864 and 27 100 between October 2007 to March 2008, respectively.

In the year prior to the pilot study (April 2007

**Table 2. Estimated costs and savings of bed days and actual costs of glycopeptides**

Study period	Number of HAIs	HAI median cost* (range)	Actual glycopeptide spend
Pre-study period	28	£217 406 (£188 888–£245 924)	£251 168
12-month pilot	5	£38 823 (£33 730–£43 915)	£124 060
Reduction in glycopeptide spend			£127 108
Estimated savings		£305 692 (£282 266–£329 117)	

HAI=hospital-acquired infection; \*calculated from Plowman 1998 adjusted to 2008 prices (25% inflation) = £6746–£8783 a pre-study period - 12-month pilot + glycopeptide savings

to March 2008), the hospital screened 1700 emergency admissions and 20 000 elective admissions for MRSA. Forty cases of MRSA bacteraemia were reported against a DoH target of 26 (*Table 1*), of which 28 were hospital-acquired (post 48 hours).

Associated costs of hospital-acquired bacteraemias were estimated to range from £188 888 and £245 924 (Plowman et al, 1999). Glycopeptide unit days were calculated for October 2007 to March 2008 as 4145 at a cost of £251 168.

### Twelve-month pilot

During the 12-month pilot study, 20 461 emergency admissions were screened using PCR and 21 461 elective admissions were screened using 42 922 culture tests (i.e. two swabs per patient). Total inpatient and day case bed-days for the period were 305 116 and 5158, respectively. Between April 2008 and March 2009, a total of nine MRSA bacteraemias were recorded (*Table 1*); a reduction of 78% over the previous year. Of these, four bacteraemias occurred less than 48 hours post-admission and five bacteraemias occurred more than 48 hours post-admission. Estimated costs of hospital-acquired MRSA bacteraemia ranged from £33 730 to £43 915 (2008 prices) (Plowman et al, 1999).

The total cost of PCR for the 12-month study period was £396 285 (staffing £68 909 and consumables £327 396). Glycopeptide unit days were 2865 during the study period. This

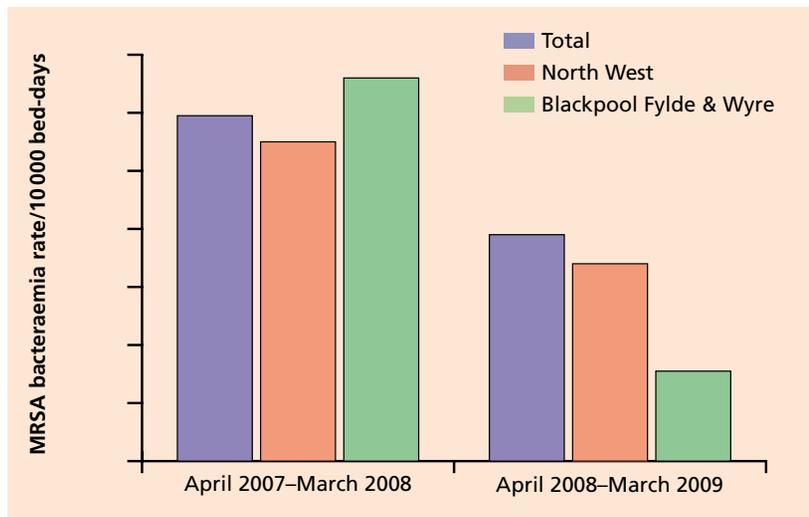
reduction in glycopeptide usage was associated with annual actual cost savings of £127 108 (2008 to 2009) over the previous financial year. Ninety-six percent of the rapid screening tests were negative. The majority of the 20 416 PCR screens were on medical patients (14 017; 69%), followed by surgical patients (5 952; 29%). The average time to reporting was five hours. The range was two to eight hours.

MRSA bacteraemias fell from 40 to 9 in the 12 months after the introduction of rapid screening. This was estimated to have saved the hospital between £282 266 and £329 117 from the reduction in bed-days and glycopeptide use (*Table 2*). The benefits of reduction in non-bacteraemia infections, including MRSA wound infections, were not calculated and are outside the scope of this study.

### Discussion

In the current study, the introduction of PCR testing for emergency admissions was associated with a fall in the number of bacteraemias. Rapidly reported results were used to complement clinical decision-making and to optimize glycopeptide use.

In the UK, prior to the introduction of mandatory reporting of MRSA bacteraemia, rates per 10 000 bed-days ranged from 1.3 to 2.4 in 2001. In the period October 2007 to March 2008, a national reduction was reported by the DoH of 0.96–1.2/10 000 bed-days (Health Protection Agency, 2008). After the implementation of the



**Figure 1. National, regional and Blackpool MRSA bacteraemia rates/10 000 bed-days**

new testing approach, the number of MRSA bacteraemias per 10 000 bed-days reduced from 1.33/10 000 bed-days (April 2007 to March 08) to 0.31/10 000 (April 2008 to March 2009) (Health Protection Agency, 2010). This trend was greater than that reported both at a regional and national level (*Figure 1*). *Figure 2* shows the overall downward trend in Trust-apportioned cases in the North West Region and Blackpool Fylde and Wyre (BFW) Foundation Trust since the end of the study period, and illustrates the ongoing benefit of the implementation of the study initiatives (Davies, 2010).

### Cost savings

Cost savings of the reduction in hospital-acquired MRSA bacteraemias from 28 to 5, estimated using the costs from the DoH, ranged from £155 158 and £202 009 (2008 prices) (Plowman et al, 1999). Other studies have calculated the difference in costs between methicillin-sensitive and methicillin-resistant bacteraemia. A study from the US published in 2000 estimated that, compared with methicillin-sensitive *Staphylococcus aureus* (MSSA) bacteraemia, methicillin resistance was associated with additional costs of \$3500 (1998 prices). This was mainly attributable to admission to the ICU and to an increased length of hospitalization (Paladino, 2000). A

recently published study from Spain estimated the cost difference between MSSA and MRSA bacteraemias to be €1206 (2008 prices) (Rubio-Terres et al, 2010).

Inappropriate antibiotic use is now widely accepted to have an association with the development of resistance. In the current study, glycopeptide usage was halved after the introduction of PCR for emergency admissions. This was associated with cost savings in excess of £127 000. It is also probable that the overall reduction in the use of unnecessary antibiotics will have a positive impact in the patterns of antibiotic resistance within the hospital.

### Banning the bugs

In spite of the overall fall in the number of MRSA bacteraemias that has recently been reported (Health Protection Agency, 2009), there is no doubt that MRSA bacteraemias represent the ‘tip of the iceberg’ in terms of numbers of infections and burden to the health care system. In our own hospital, in the financial year prior to the introduction of rapid PCR screening, 629 MRSA wound infections were recorded. Post implementation of rapid testing, these had fallen to 485, a reduction of 33%. This reduction in wound infections may reflect a further benefit of rapid screening, although the analysis of this is outside the scope of the current study.

A ‘Ban the Bugs’ campaign was also introduced in our Trust. This used banners and posters on the approach road to the hospital campus and hospital corridors, with simple and catchy infection control messages, to raise staff and public awareness regarding hospital-acquired infections (HAIs), which was a high priority for the Trust Management and Hospital Infection Control Committee. Mandatory infection prevention training for all staff was conducted by executive directors. The hospital also introduced ‘hand hygiene champions’ and audits, and a

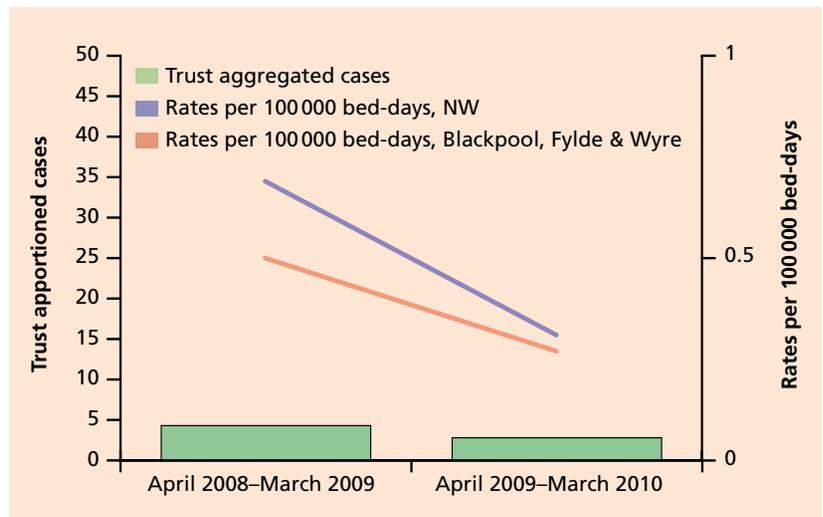
new 'bare below the elbow' uniform policy. The infection prevention team was expanded and a new director of infection prevention and control (DIPC) appointed. A MRSA counter was installed on all Trust computers, indicating the days from the last MRSA bacteraemia and a reminder about hand hygiene.

One criticism of the current study is the confounding nature of the introduction of other interventions at the same time. The decreased time to reporting the results of screening in the current study was not affected by these other initiatives.

### The debate

There is still a lot of debate about the benefits of universal screening (Peterson and Diekema, 2010), and a number of studies have reported that the costs are not justified, particularly in patient populations where there is low MRSA endemicity (Buhlmann et al, 2008; Harbarth et al, 2008; Herdman et al, 2009; Sturenburg, 2009; Flore et al 2010 Murthy et al, 2011). Other groups have reported that the use of PCR for screening admissions is cost-effective (Schulz et al, 2009). The benefits of reducing turnaround time have been reported in three recently published studies (Aldeyab et al, 2009; Sturenburg, 2009; Brenwald et al, 2010). A large study from The Netherlands reported that use of PCR with decolonization reduced the relative risk of surgical site infection by 0.42 (95% CI, 0.23 to 0.75) (Bode et al, 2010).

Other investigators have reported that the use of PCR may improve the appropriateness of initial antibiotic therapy in sepsis (Lehmann et al, 2009), and also reduce the number of unnecessary isolation days (Jeyaratnam et al, 2008; Schulz et al, 2009). A recent article has postulated that universal screening 'breaches ethical guidelines', and that there is little scientific justification for its implementation



**Figure 2. Regional and Blackpool Fylde & Wyre Trust trends post-study conclusion (Davies, 2010)**

(Millar, 2009). However, the reduction in the number of MRSA bacteraemias at Blackpool Victoria Hospital would seem to justify the implementation of universal screening.

One of the salient differences between previous studies on the use of PCR screening for MRSA and the current study is that this study was not designed to compare culture versus PCR. The current study approached the problem of MRSA bacteraemias in a holistic way. During and after the study, there was a transformation in staff approach, understanding and attitude towards HAI, including MRSA and infection prevention control. One of the main outcomes of the initiative was the associated clinical advantages of obtaining a rapid result to inform patient management as a guide to antibiotic choices.

### Implications of findings

Despite the limitations of the current study, where multiple interventions were introduced simultaneously, we believe that this is the first report of the benefits of introducing PCR rapid testing in terms of enhancing clinical decision-making, patient safety and assurance, reducing the number of MRSA infections and cost-effectiveness of the programme. A recently published article postulated that the lessons that have been learnt from the various initiatives implemented for controlling MRSA spread and infection may also provide useful models for

## KEY POINTS

- Rapid confirmation of MRSA carriage allows infection control protocols to be targeted to minimize transmission and infection risks
- Rapid reporting of results prevents unnecessary isolation of patients with high risk of MRSA carriage
- The key to implementing this initiative was the active partnership and co-operation between the Trust management (including the Chief Executive) and infection control, medical and pharmacy teams
- Rapid results provide patient reassurance, complement clinical decision and optimize antibiotic usage.

managing methicillin-sensitive and methicillin-resistant *S. aureus* (Lucet and Regnier, 2010). The findings of the current study may, therefore, have wider implications for the overall detection and management of both methicillin-sensitive and methicillin-resistant *S. aureus*, especially in areas of high prevalence.

### Working together

In the current study, the key to the successful implementation of the initiative was the active partnership between the Trust management (the CEO and the Deputy CEO) and the enhanced infection control team (involving the antibiotic pharmacist and both clinical microbiologists). The active involvement of the CEO as the Head of the Hospital Infection Control Committee was also integral to its success. The development of active infection control and management through rapid reporting also improved clinical engagement and communication between multi-disciplinary teams. It transformed the approach to the management of HAIs within the hospital. Clinical bedside microbiology consultations during ward rounds helped to engage the clinical teams. In addition, the mandatory infection control roadshows run by clinical and non-clinical executive directors reinforced the message about the importance of infection prevention. MRSA performance management meetings (with clinical teams, following every case of bacteraemia, to look at root cause analysis of events leading up to diagnosis) was pivotal in raising awareness within the hospital.

The knowledge of MRSA status permits both optimization of antibiotics for infection and/or

targeted infection control interventions, thereby reducing the potential of transmission/self-infection following any invasive procedure. [BJHCM](#)

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### Conflict of interest statement:

AG has received international speaker fees from BD, and is an honorary member of the BD speaker panel in the UK. AK, JH, BL, NH, RP and AJ have no conflict of interest to declare.

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