

# Improving the management of Staphylococcus aureus bacteraemia, including MRSA

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## Abstract

Staphylococcus aureus bacteraemia is a serious infection associated with significant complications, including recurrence of bacteraemia, endocarditis and metastatic foci of infection. The management of these patients is often complex, involving appropriate source control, a thorough review and investigations to exclude metastatic foci and infective endocarditis. Additionally, a prolonged course of intravenous antibiotics is often required.

As part of our quality improvement project, the following five aspects were evaluated in 56 patients with S. aureus bacteraemia at two District General Hospitals: 1) adequate and timely removal of the source of bacteraemia, 2) echocardiography to exclude endocarditis, 3) repeat blood culture to prove clearance of bacteraemia, 4) adequate duration and choice of antibiotics and 5) documentation of bacteraemia in the discharge summary.

After an initial review revealed several areas for improvement, we instituted five Plan-Do-Study-Act learning cycles which involved: teaching microbiology trainees and junior doctors, improving clinical liaison and communication between the microbiology team and clinicians, as well as a clinical review of patients by the microbiology team where appropriate.

The post-intervention review evaluated 24 patients with S. aureus bacteraemia between November 2012 and May 2013. The proportion of patients undergoing an echocardiogram improved from 49% to 88%. Another marked improvement was seen in the timely obtaining of clearance blood cultures, with 88% of patients having clearance blood cultures within the 2-4 day window, compared to 56% pre-intervention. 70% of patients with uncomplicated S. aureus bacteraemia received an appropriate antibiotic course post-intervention, compared with 59% pre-intervention. Documentation of the S. aureus bacteraemia in the discharge summary improved from 65% to 75%. The support of the entire microbiology team was pivotal in the successful outcome of the quality improvement project.

## Problem

Staphylococcus aureus is a common cause of both community and hospital acquired bacteraemia, and is associated with significant morbidity and mortality. The management of Staphylococcus aureus bacteraemia is multi-faceted. It often requires prolonged courses of antimicrobial therapy as well as a thorough assessment and investigations to identify the source and seek any complications, such as metastatic foci. Given the meticulous approach required when treating patients with S. aureus bacteraemia, there is potential for some aspects of optimal management to be missed, especially in an environment where time and bed space are at a premium. Failure of any aspect of the optimal management, however, is associated with negative patient outcomes.

## Background

S. aureus bacteraemia is associated with a mortality of 20-30%, and suboptimal management can significantly impact on the associated morbidity (1, 2, 3). Failure to remove an infected intravascular focus increases the risk of treatment failure,

recurrence of S. aureus bacteraemia and metastatic complications (4, 5). Based on this data, our first measurement evaluated the adequacy and timely removal or debridement of the source of bacteraemia.

Endocarditis is a well documented complication in around 12% of cases, although rates vary between different population groups and rates from 5% up to 60% have been reported (2, 3). This highlights the need for echocardiography in all cases of S. aureus bacteraemia, even in the absence of peripheral stigmata of endocarditis. The British Society for Antimicrobial Chemotherapy (BSAC) and the Infectious Diseases Society of America (IDSA) both recommend echocardiography in all cases of S. aureus bacteraemia in their guidelines (6, 7). Based on these guidelines, our second measurement assessed whether echocardiography was performed in all adult patients with Staphylococcus aureus bacteraemia.

Obtaining a repeat blood culture is recommended after initiation of appropriate treatment. This enables the early identification of complications and persistence of bacteraemia. Hence our third measurement assessed whether clearance blood cultures were obtained.

Treatment of less than two weeks is associated with a higher risk of complications (8). The presence of an irremovable or undrainable primary focus, endocarditis, a metastatic focus of infection or persistence of bacteraemia are all indications for prolonged antimicrobial therapy of four to six weeks (6, 7, 9, 10). It is uncertain whether de-escalation to oral therapy impacts on the relapse rate.

Based on this evidence, the fourth measurement evaluated the adequacy of antimicrobial duration and choice. A minimum of two weeks of intravenous antibiotics for uncomplicated bacteraemia, and four to six weeks of antibiotics for complicated bacteraemia was considered adequate.

Documentation of *S. aureus* bacteraemia in the discharge summary enables earlier identification of complications following a patient's discharge, such as recurrence of bacteraemia, metastatic foci of infection or endocarditis. The fifth measurement assessed whether *S. aureus* was documented in the discharge summary.

A previous study revealed that patients under the care of medical teams who did not follow the treatment recommendations by infectious diseases consultants were more likely to experience a relapse of the bacteraemia (4). Many of the project's Plan-Do-Study-Act learning cycles were therefore centred around improving clinical liaison between the clinicians and the microbiology team.

## Baseline measurement

In order to determine the scale of the problem, the management of 56 patients with *Staphylococcus aureus* bacteraemia was reviewed at the Royal Hampshire County Hospital (January 2012 to October 2012) and the Basingstoke and North Hampshire Hospital (April 2010 to May 2011), both part of the Hampshire Hospitals Foundation Trust. The following five aspects were assessed:

1. Adequate and timely removal or debridement of the source of bacteraemia
2. Echocardiography in adults with *S. aureus* bacteraemia to exclude or confirm endocarditis
3. Repeat blood culture to prove clearance of bacteraemia or allow early identification of complications
4. Adequate duration (minimum of two weeks of intravenous antibiotics for uncomplicated bacteraemia, four to six weeks of antibiotics for complicated bacteraemia) and choice of antibiotics
5. Documentation of bacteraemia in the discharge summary

The above baseline measurements were obtained by reviewing patient notes as well as the microbiology bacteraemia notes and discharge summaries. Echocardiography findings were obtained by liaising with the echocardiography department. The adequacy of antibiotic treatment was assessed by reviewing the electronic drug prescribing records. All microbiology results were reviewed, including initial and repeat blood cultures as well as cultures from other sites indicating possible sources or metastatic foci of infection.

The most common sources identified in the baseline study were skin or soft tissue infection (26%) and bone or joint infection (21%).

Adequate source control was obtained in almost all the patients (96%). However, just under half (49%) of the patients studied underwent echocardiography, and just over half (56%) had clearance blood cultures within the required time frame. Only 59% of patients with uncomplicated *S. aureus* bacteraemia received an appropriate treatment course, whilst all patients with a complicated *S. aureus* bacteraemia received an adequate duration of therapy (see figure 1 for definition of uncomplicated and complicated bacteraemia). The diagnosis of a *S. aureus* bacteraemia was included in the discharge summary of 65% of the patients.

See supplementary file: ds1862.doc - "Figure 1 Uncomplicated versus complicated bacteraemia"

## Design

It was felt that the key to improving the management of *S. aureus* bacteraemia was through education and encouraging clear communication between microbiologists and clinicians, as well as bedside review of patients by the microbiology team where applicable. In order to create a sustainable improvement in practice, awareness and teaching was targeted at different members and levels of the clinical team, including the microbiology team, junior doctors and more senior clinicians.

## Strategy

### PDSA cycle1

Teaching on 'Optimising the management of *S. aureus* bacteraemia' at the regional microbiology training day, Wessex deanery (November 2012).

### PDSA cycle 2

Present findings of the baseline measurements as well as the proposed improvement plan at the Quality event Hampshire Hospitals Foundation Trust (February 2013). Disseminate initial results to the microbiology consultants across both hospital sites (December 2012).

### PDSA cycle 3

Improve clinical liaison and communication between microbiology team and clinicians by specifically recommending echocardiography in patients with significant *S. aureus* bacteraemia, as well as documentation in patient notes where applicable (November 2012 to May 2013).

### PDSA cycle 4

Clinical review of patients on the ward by the microbiology team as indicated, optimising the initial management and documenting the advice to enhance collaboration between the teams (November 2012 to May 2013).

### PDSA cycle 5

Discussion with junior doctors at their Foundation teaching with regards to documentation of bacteraemias in the discharge summary, allowing prompt identification of subsequent recurrence of bacteraemia or metastatic foci of infection (Royal Hampshire County Hospital, May 2013).

## Results

Following the implementation of the quality improvement project, the management of patients with *S. aureus* bacteraemia was reviewed using the same methods and measurements as was used in the baseline study.

24 patients with *S. aureus* bacteraemia were identified between November 2012 and May 2013 (Figure 2). Bone or joint infection and line or medical device infection were the most common sources of bacteraemia (29% and 25% respectively). As noted in the pre-intervention study, adequate source control was obtained in almost all patients (96%). Encouragingly, the proportion of patients undergoing an echocardiogram after the intervention was markedly improved, with 88% of patients undergoing the investigation, compared to 49% pre-intervention. Another marked improvement was seen in the timely obtaining of clearance blood cultures, with 88% of patients having clearance blood cultures within the 2-4 day window, compared to 56% pre-intervention.

Similar to the baseline study, all patients with complicated bacteraemia received a minimum of four weeks of antibiotics. Importantly, 70% of patients with uncomplicated *S. aureus* bacteraemia in the post-intervention group received an appropriate duration of antibiotic treatment, compared to 59% in the pre-intervention group. *S. aureus* bacteraemia was also more frequently documented in the discharge summary (75% in the post-intervention group versus 65% in the pre-intervention group).

See supplementary file: ds1864.doc - "Figure 2. Results of baseline and post-intervention study."

## Lessons and limitations

Whilst implementing the Plan-Do-Study-Act learning cycles, it became evident that the engagement and support of the entire microbiology team was pivotal in raising the standard of management of *S. aureus* bacteraemia.

There was also a marked improvement in the management of patients when the microbiology team reviewed the patients on the ward and documented directly in the patient notes, rather than just consulting over the telephone. Daily bacteraemia ward rounds were already common practice at one of the two District General Hospitals.

Although this project was not designed to evaluate patient outcome, it was noted that less than two weeks of intravenous anti-staphylococcal treatment appeared to be linked to recurrence of bacteraemia in the post-intervention group. Two of the three patients who received less than two weeks of intravenous anti-

staphylococcal treatment developed a recurrence of *S. aureus* bacteraemia within two months. None of the other patients in the post-intervention group have developed a recurrence of *S. aureus* bacteraemia to date. Whilst a reduced duration of antibiotic therapy in the short-term may appear cost-effective, the long-term impact on both patient outcome and hospital resources outweighs these immediate gains. Furthermore, a hospital stay may not be required for the entire duration of intravenous therapy, since antibiotics can be safely administered via the 'Rapid Access Clinic' in the Medical Admissions Unit or via Outpatient Antimicrobial Therapy (OPAT).

The post-intervention study was performed over a shorter timescale than the baseline study, which is one of the limitations of the project. As a result, there were fewer patients in the post-intervention study. Nonetheless, it was felt that there were sufficient numbers of patients in the post-intervention study for the improvements found to represent a real change in management.

## Conclusion

*Staphylococcus aureus* bacteraemia is a common, but serious infection associated with significant morbidity and mortality. The project aimed to improve the multi-faceted and sometimes complex management of these patients by implementing five 'Plan-Do-Study-Act' learning cycles at two District General Hospitals. The post-intervention review showed significant improvement in the number of patients receiving appropriate antimicrobial treatment for uncomplicated *S. aureus* bacteraemia, exclusion of endocarditis by echocardiography and demonstrating clearance of the bacteraemia by follow-up blood cultures. The support of the entire microbiology team was pivotal in the successful outcome of the quality improvement project.

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## Declaration of interests

Nothing to declare.

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