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Reduction in the rate of methicillin-resistant *Staphylococcus aureus* acquisition in surgical wards by rapid screening for colonization: a prospective, cross-over study

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Abstract

Identification of patients colonized with methicillin-resistant *Staphylococcus aureus* (MRSA) and subsequent isolation and decolonization is pivotal to the control of cross infection in hospitals. The aim of this study was to establish if early identification of colonized patients using rapid methods alone reduces transmission. A prospective, cluster, two-period cross-over design was used. Seven surgical wards at a large hospital were allocated to two groups, and for the first 8 months four wards used rapid MRSA screening and three wards used a standard culture method. The groups were reversed for the second 8 months. Regardless of the method of detection, all patients were screened for nasal carriage on admission and then every 4 days. MRSA control measures remained constant. Results were analysed using a log linear Poisson regression model. A total of 12 682/13 952 patient ward episodes (PWE) were included in the study. Admission screening identified 453 (3.6%) MRSA-positive patient ward episodes, with a further 268 (2.2%) acquiring MRSA. After adjusting for other variables, rapid screening was shown to statistically reduce MRSA acquisition, with patients being 1.49 times (p 0.007) more likely to acquire MRSA in wards where they were screened using the culture method. Screening of surgical patients using rapid testing resulted in a statistically significant reduction in MRSA acquisition. This result was achieved in a routine surgical service with high bed occupancy and low availability of isolation rooms, making it applicable to the majority of health-care systems worldwide.

Keywords: Colonization, methicillin-resistant *Staphylococcus aureus*, molecular, rapid screening, transmission
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Introduction

Methicillin-resistant *Staphylococcus aureus* (MRSA) is an important hospital-acquired infection, the prevalence of which has increased, despite the introduction of multifaceted control measures [1,2]. Successful control measures have mainly relied upon the identification and isolation of colonized and infected patients to prevent them acting as a reservoir of infection and onward transmission [3–6]. The important unanswered question, addressed by this study, is whether a more rapid diagnosis of colonization or infection confers additional benefits over traditional culture-based methods [7].

Recently developed molecular methods, using PCR have the potential to confirm or refute colonization and infection of individual patients within 2 h. One such commercially available real-time PCR test links *mecA*, the gene responsible for methicillin resistance, to a *S. aureus* genomic background, thereby avoiding false positives [8]. Several studies have evaluated this test and shown it to have both high sensitivity and negative predictive value [9–12].

We have designed and executed a prospective controlled cross-over study within the surgical wards of a single large hospital to test the hypothesis that early identification of MRSA colonized and infected patients reduces onward transmission of MRSA compared with traditional culture-based methods.

Materials and Methods

Study setting and design

The study was based in a large teaching hospital of 1200 beds and carried out in seven surgical wards (number of wards): general surgery (2), thoracic (1), ear, nose and throat (ENT) (1), trauma and orthopaedic (2) and urology (1). Each ward had between 20 and 34 beds, arranged in bays of six beds and two to five single isolation rooms.

A prospective, cluster two-period cross-over design was used, with the only difference between the two periods being the method of MRSA detection [13]. The study compared the use of rapid MRSA testing with the BD GeneOhm™ molecular test (BD Diagnostics—GeneOhm, San Diego, CA, USA) with a standard direct inoculation culture method using chromogenic (MRSA ID) media (Biomerieux, Marcy, l'Etoile, France). Wards were assigned to one of two groups (A to D and E to G), with wards of a similar specialty being placed in opposite groups. An initial study over a 2-month pilot period, after group assignment and introduction of test methods, was conducted according to the study protocol. This was followed by two 8-month cross-over periods, with 1-month follow-up of study patients at the end of the final period.

A screening protocol was implemented, requiring all adult patients admitted for >24 h to have a nasal sample taken on admission. In order to identify transmission events and acquisition while on the ward, all patients who were negative on admission were re-screened every 4 days until discharge. Patients known to be positive from previous admission were still screened on admission.

Laboratory procedures and reporting

On receipt in the laboratory all swabs, including those from the wards where the samples were being tested using the rapid test, were inoculated directly onto chromogenic culture media. Subsequently the swabs requiring the rapid test were processed according to the manufacturer's instructions. Rapid results were reported immediately on completion of the test without awaiting a culture result. Culture plates were read after 18-h incubation and MRSA isolates confirmed the following day using standard methods [14]. Mupirocin sensitivity was carried out on all isolates according to British Society Antimicrobial Chemotherapy methods. Where there were discrepant results between rapid and culture tests, samples were placed in broth enrichment, incubated overnight and then sub-cultured onto chromogenic media. Results from all tests were entered on the hospital reporting system and all positive MRSA results, rapid and culture, were telephoned. A 7 day per week service was provided.

Infection control procedures

All wards were provided with the same infection control guidelines, which remained unchanged for the duration of the study. Only upon a positive test result were patients placed under control measures. These included placing the patients in an isolation room, if available, and placement of an isolation precaution sign detailing the infection control measures, including hand hygiene and the wearing of an apron, that should be taken either on entry to the room or above the bed space. Gloves were only required when handling blood, body fluids, secretions, excretions and contaminated materials. All patients were commenced on decolonization treatment [nasal mupirocin or naseptin for strains with high level mupirocin resistance and triclosan body wash (Aquasept®) administered three times a day for 5 days].

Data collection

Dedicated staff collected a comprehensive set of data for all patients admitted to the study wards. This included demographic information, risk factors, source of admission, antibiotic usage, length of stay, bed movements and type of surgery. For all patients who were colonized or infected with MRSA, the times of implementation of infection control measures and decolonization treatment were also recorded. Turnaround times for MRSA screening results, from taking a sample to reporting, were recorded for all samples.

Outcome measures

The primary outcome of the study was the acquisition rate of MRSA colonization. As a result of differences in sensitivity between the rapid and culture tests, acquisition rates were calculated using only culture results which were obtained consistently in all arms of the study. A patient was deemed to be colonized with MRSA on admission to a ward if MRSA was isolated within 48 h of admission. If a patient did not have an admission sample, but a negative sample was taken within 4 days of the ward admission, the patient was regarded as not being colonized with MRSA on admission. Patients were excluded from the analysis if they had no samples taken or if they had a positive 4-day sample, but no admission sample (Fig. 1).

In order to account for colonization pressure, acquisition rates were calculated as the ratio of the number of patients acquiring MRSA on the ward to the number of patients who were MRSA positive on admission. Analysis was carried out at the ward level and, to take account of the fact that during the study some patients moved between study wards,