

# A sustained reduction in the transmission of methicillin-resistant *Staphylococcus aureus* in an intensive care unit

Elizabeth E Gillespie, Fiona J ten Berk de Boer, Rhonda L Stuart, Michael D Buist and Jill M Wilson

Methicillin-resistant *Staphylococcus aureus* (MRSA) emerged as a major pathogen in Australian hospitals in the late 1970s. Since then, MRSA has established itself as one of the leading nosocomial pathogens.<sup>1,2</sup> Infection with MRSA prolongs hospital stay, increases staff workload and hospital costs, and increases morbidity and mortality. Controlling MRSA endemicity is regarded as essential and cost-effective.<sup>3,4</sup>

Infection control programs were created in the 1970s in response to the emergence of healthcare-associated antibiotic resistant pathogens.<sup>3</sup> The US Centers for Disease Control and Prevention (CDC) have for many years recommended contact precautions (eg, gloves and gowns) for patients colonised or infected with MRSA. Research has confirmed that antibiotic use and patient-to-patient transmission are the most important risk factors for infection caused by antibiotic-resistant pathogens.<sup>5,6</sup>

Dandenong Hospital is a 444-bed tertiary referral teaching hospital in Melbourne, Australia. From 2001 to 2005, the intensive care unit accommodated up to nine patients at a time. Beds were arranged side by side with a distance of 1–2 m between patients, and one single room available for isolation. The unit averaged 500–550 admissions per year, including both medical and surgical patients. Hand basins were located at each end of the unit, within the single room and in the centre of the unit at the “write-up” area. A new ICU was opened in June 2005 with a 14-bed capacity. Distance between patients then increased to at least 2–3 metres.

In 2001, ICU staff began active MRSA screening of patients on admission, discharge, and weekly. Screening comprised nose and groin swabs taken on admission, weekly and at discharge. Screening was initially performed as point prevalence surveys. However, following the identification of vancomycin intermediate-resistant *S. aureus* (VISA) in 2001, continuous screening was conducted on admission, weekly and at discharge until the end of 2002. VISA is not fully resistant to vancomycin but has reduced susceptibility, rendering vancomycin unreliable for treatment of infections. As no further VISA strains were identified, continuous screening ceased during 2003, but was re-commenced several months later as a staff-initiated quality activity.

Incidence of MRSA failed to decrease between 2001 and 2003, despite feedback of the results of the screening

## ABSTRACT

**Introduction:** In 2001, screening for methicillin-resistant *Staphylococcus aureus* (MRSA) was initiated in the intensive care unit at Dandenong Hospital, Melbourne, Australia. This followed the identification of a clinical isolate of vancomycin intermediate-resistant *S. aureus* (VISA). Contact precautions for patients colonised or infected with MRSA or VISA were utilised, together with the promotion of hand hygiene and additional environmental cleaning. In 2004, poor compliance with hand-hygiene requirements was recognised as potentially contributing to the inability to control MRSA transmission.

**Methods:** A renewed campaign was introduced in 2004, aimed at improving hand hygiene in the ICU. This involved the introduction of an alcoholic chlorhexidine handrub station on a trolley at the door of the ICU. Use of alcoholic chlorhexidine handrub was mandated for existing and visiting staff to the ICU, and its use was actively promoted by all ICU staff.

**Results:** From 2001 to 2004, the average monthly acquisition of MRSA in the unit was 15.2 patients per 1000 occupied bed days (OBD). Following the implementation of the campaign aimed at visiting staff, the average acquisition of MRSA dropped to 3.2 patients per 1000 OBD.

**Conclusions:** Ownership of hand-hygiene responsibility for patients’ protection appeared to contribute to the success of this initiative. The ability to sustain the excellent result was enhanced by the unit leadership and the empowerment of the nurse at the bedside to be the patient’s advocate. Nurses, who are at the patient bedside 24 hours per day, 7 days per week, are well positioned to reinforce appropriate hand hygiene.

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program to the ICU. Alcoholic handrub was introduced at the end of each bed in 2002, and shadowing and hand-hygiene awareness campaigns were conducted in the ICU at regular intervals. However, a new clinically important strain of MRSA (rifampicin-resistant) was identified as a clonal outbreak in June–August 2004.<sup>7</sup> This stimulated a renewed focus on transmission of resistant pathogens in the ICU.

**Table 1. Strategic change management in the intensive care unit**

Existing practice, 2002–2004	New interventions and strategies from 2004
<ul style="list-style-type: none"> <li>Alcoholic chlorhexidine handrub accessible at each patient</li> <li>Contact precautions for patients with methicillin-resistant <i>Staphylococcus aureus</i> (MRSA)</li> <li>Education of staff</li> <li>Shadowing to raise awareness of infection control practice</li> <li>Annual environmental audit by infection control team and reviews of unit compliance with infection control standards and guidelines.</li> </ul>	<ul style="list-style-type: none"> <li>Alcoholic chlorhexidine handrub attached to notes table at foot of bed in addition to bedside equipment table</li> <li>“Drinks trolley” and “door monitor” provided physical barrier at entrance</li> <li>Staff empowered to promote appropriate hand hygiene throughout the unit</li> <li>Feedback of MRSA rates and compliance with screening helped empower staff and promote ownership</li> <li>Screening packs were prepared and promoted routine screening</li> <li>Increased infection control presence in ICU helped educate and promote hand-hygiene awareness</li> </ul>

We describe the initiatives that successfully reduced MRSA transmission, and the capacity to sustain these results.

## Methods

In the ICU at Dandenong Hospital, all patients known to be colonised or infected with MRSA were cared for using additional contact precautions.<sup>8</sup> As there was only one single room in the unit before 2005, when there was more than one patient with MRSA, they were “cohorted” at the far end of the unit.

### Stage 1 infection control initiatives

Infection control initiatives introduced in 2002 are listed in Table 1 (*Existing practice*). Shadowing was introduced

to promote the use of alcoholic chlorhexidine handrub as an effective hand-hygiene strategy. This involved the infection control consultant observing individual ICU staff members (after obtaining their permission) as they attended to patient care for 5–10 minutes, and providing feedback. Positive activity, such as the appropriate use of hand hygiene, was encouraged. Improvements, such as use of eye protection during patient care, were tactfully suggested. In-service education on hand hygiene was provided to promote the advantages of handrub and the potential opportunities for use. Staff experiencing hand or skin care problems were assessed by the infection control team and, if necessary, referred to an occupational dermatologist.

The infection control team reported monthly MRSA acquisition rates to ICU staff. Alcoholic chlorhexidine handrub was available on each patient’s equipment trolley, with additional handrub attached to the notes table at the end of the bed.

### Stage 2 infection control initiatives

In 2004, screening packs containing pre-printed pathology slips, swabs and instructions were included in the ICU admission bundle. ICU admission forms included a tick box to prompt staff about the admission screen. A trolley with bottles of alcoholic chlorhexidine handrub was placed inside the entrance to the ICU and referred to as the “drinks trolley” (Figure 1). The nurse caring for the patient closest to the ICU entry became the “door monitor”. This nurse was responsible for monitoring staff entering the unit for compliance with the hand-hygiene requirements and was empowered to follow up or notify ICU management of non-compliance.

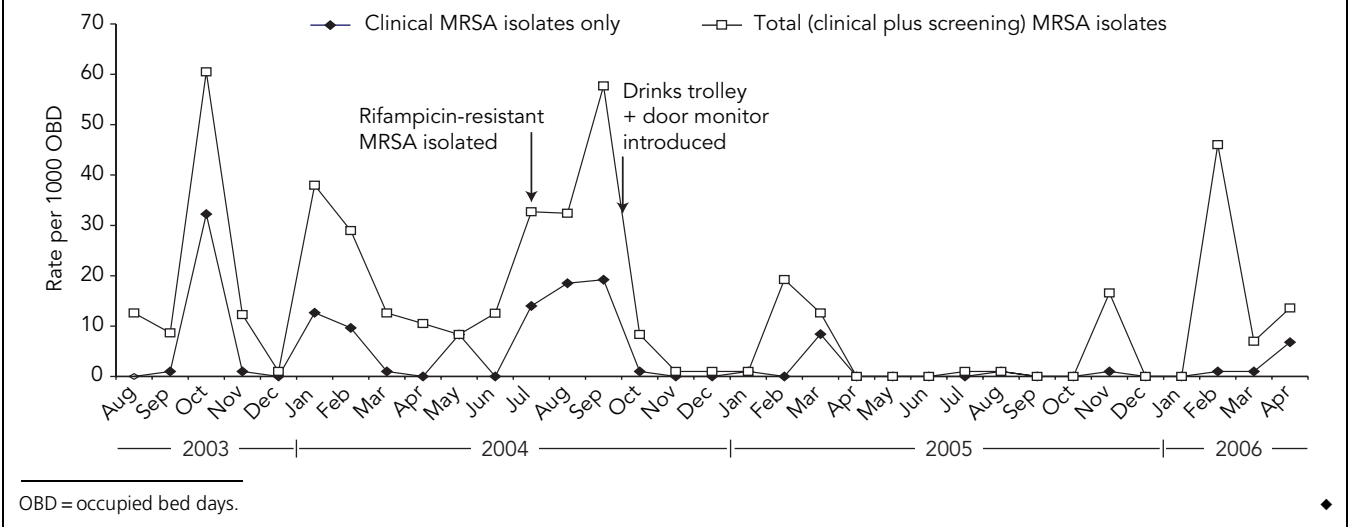
Molecular typing of isolates was conducted to provide epidemiological information about transmission within the ICU. Only clinically significant isolates of MRSA (ie, urine,

**Figure 1. The “drinks trolley”**



A trolley with a bottle of alcoholic chlorhexidine handrub was placed as a physical barrier at the entrance to the intensive care unit. ♦

**Figure 2. Rates of acquisition of methicillin-resistant *Staphylococcus aureus* (MRSA) in the intensive care unit of Dandenong Hospital**



sputum and blood culture) underwent molecular testing using the conventional “gold standard”, pulse field gel electrophoresis (PFGE). This provided an analysis of chromosomal DNA.

Screening compliance was reported at monthly meetings and informally to staff at the bedside. Staff designed their own hand-hygiene posters and placed them above sinks and around the ICU. An increased infection control presence in the ICU helped develop rapport between ICU and infection control staff and promoted “hand hygiene every time” as the norm.

In February 2006, a reduction in allocated cleaning hours prompted a review of cleaning activities within the unit, including the number of hours allocated to cleaning and the methods used.

## Results

Rates of acquisition of MRSA — both clinical and total (screening and clinical) isolates — in Dandenong ICU between 2003 and 2006 are compared in Figure 2. In September 2004, despite ongoing education and increased infection-control presence, eight patients acquired MRSA. This corresponded to 38.4 patients per 1000 occupied bed days [OBD], the highest rate of MRSA acquisition in the ICU since the introduction of infection control initiatives in 2004.

Rifampicin-resistant MRSA was first isolated in June 2004. In 2002, 0.3% of clinical MRSA isolates in Southern Health, Victoria, had been rifampicin-resistant. In 2004, this increased to 3.3%. The increase was accounted for by a clonal outbreak of rifampicin-resistant MRSA within Dande-

nong ICU, with seven ICU patients identified with this organism between June and August 2004.<sup>7</sup>

The ICU began to focus on transmission, with the drinks trolley and door monitor introduced after the September 2004 monthly result. Table 1 describes the existing practices in place and the strategies initiated to promote change.

From October 2004 to October 2005, the monthly rate of MRSA acquisition in the ICU decreased to an average of 3.2 per 1000 OBD. Previously (August 2003 to October 2004) the acquisition rate of MRSA was 15.2 per 1000 OBD.

Molecular typing confirmed that the rifampicin-resistant MRSA strains were identical, with staff hands the most likely mechanism of transmission.<sup>7</sup> PFGE results for the rifampicin-sensitive MRSA strains showed that they comprised predominantly two strains, indicating clonal spread.

## Discussion

Our patients were screened for MRSA on admission, enabling us to demonstrate the transmission of the unique strain of rifampicin-resistant MRSA. When this information was presented, ICU staff made comments such as, “If a patient stays long enough of course they’ll get MRSA”, and “Our patients are compromised and therefore more susceptible”. The average length of stay for patients in the ICU at Dandenong Hospital in 2004 was 3.9 days. Studies have suggested that length of stay in the ICU is a strong predictor of MRSA acquisition.<sup>9</sup> However, the outbreak of rifampicin resistance was concerning and stimulated a new focus on preventing transmission.

Staff visiting the ICU were often observed failing to adhere to appropriate hand hygiene. Screening provided

the capacity to demonstrate transmission, as the identification of clinical isolates on its own could not (Figure 2). Previously, there was a belief that absence of patient contact meant hand hygiene was not required. Most staff understood the principle of hand hygiene, but did not recognise that, after they had handled patient notes at the end of the bed, they needed to apply handrub.

The strategic change management that was implemented is summarised in Table 1. A no-blame approach was adopted, with staff reminded in a non-threatening manner by their ICU colleagues. Staff became progressively more at ease with reminding colleagues to apply handrub.

The drinks trolley was a focus that helped stimulate discussion about appropriate hand hygiene. The trolley gave the perception of a barrier that was obvious on entry and appeared to help promote hand hygiene as staff entered the unit. The door monitor role also created a focus for discussion about appropriate hand-hygiene practice. This fostered team building as well as reinforcing appropriate infection control practice.

Unit heads reinforced hand hygiene at the commencement of each ward round. Application of handrub followed by instructions for the team to adopt the same approach was routine. Any person entering the unit who failed to apply handrub was asked to comply. Nursing staff were empowered as patient advocates, and adopted a routine approach to the application of handrub. As there was only one entrance to the unit, hand hygiene on entry was able to be closely monitored. All visitors to patients were included in the hand hygiene requirement. Patient visitors soon became accustomed to the application of hand hygiene, and the trolley or handrub station became familiar to all visiting medical and nursing staff.

The difference that contributed to the success of this hand-hygiene campaign compared with previous efforts appeared to be the ownership by individuals and the demonstrated leadership by unit heads. The medical director of the ICU was unrelenting in promoting and encouraging hand hygiene, and educated by example. The nurse as patient advocate was consistently reinforced as an important element in making the difference.

Staff at all levels participated. Feedback of results at audit meetings was well received. ICU staff recognised the decrease in MRSA acquisition was a direct result of their efforts. ICU infection control liaison staff provided updates of results to weekend and night staff unable to attend audit meetings.

The sustained reduction in MRSA transmission was associated with a new ownership of hand hygiene and a cultural change that recognised hand hygiene as the single most important factor in preventing the transmission of infection.<sup>10</sup>

The reduction in the ICU MRSA rate created a positive response across the hospital. Staff from other clinical areas

noticed fewer patients with MRSA admitted to their units from the ICU. The reduction in the MRSA rate was sustained following relocation to the new unit in June 2005. The new ICU is spacious with no overcrowding. However, it has three entrances, making monitoring of visiting staff entry more difficult. The ICU hand-hygiene requirements are promoted consistently to all hospital staff through their contact with the unit.

In 2006, there was a sudden increase in the acquisition of MRSA, with 11 patients acquiring MRSA in 1 month. This sudden increase prompted a review of activity. On investigation, the allocation of cleaning hours had been significantly reduced in the unit. A return to previously allocated cleaning hours was established by March 2006, and over the ensuing 2 months only two more patients acquired MRSA. The return to an MRSA acquisition rate of 5.15 per 1000 OBD was similar to that seen in the latter part of 2004 and all of 2005.

A staff change of focus to problem ownership and patient advocacy was demonstrated from mid-2004. New employees to the unit are introduced to the unit expectations about infection control practice on arrival.

## Conclusions

The outstanding difference between this hand-hygiene campaign compared with previous efforts was the leadership that reinforced, promoted and strengthened adherence to strategies already in place. The flow-on was the empowerment of nurses, which provided the unit with a mechanism to constantly reinforce appropriate hand hygiene. ICU staff were proud of their achievement. Additional precautions were required less often, and the staff appreciated this as a significant advantage to themselves, as well as to the safety of their patients.

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