Infection-free surgery: how to improve hand-hygiene compliance and eradicate methicillin-resistant *Staphylococcus aureus* from surgical wards

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ABSTRACT

INTRODUCTION Healthcare-associated infections cost the UK National Health Service £1 billion per annum. Poor hand hygiene is the main route of transmission for methicillin-resistant *Staphylococcus aureus* (MRSA), leading to increased mortality and morbidity for infected patients. This study aims to quantify MRSA infection rates and compliance of alcohol gel application at the entrance to a surgical ward and assess how a simple intervention affects compliance.

SUBJECTS AND METHODS Compliance was assessed via a discretely positioned close-surveillance camera at the ward entrance. Footage was reviewed to monitor compliance of all persons entering the ward over a 12-month period.

RESULTS For the initial 6 months, mean alcohol gel compliance was 24% for all persons entering the ward. After this period, a conspicuous strip of bright red tape was positioned along the corridor approaching the ward entrance. The red line continued up the wall to an arrow head pointing to the two alcohol gel dispensers on the wall. Mean compliance over the subsequent 6 months significantly improved to 62% ($P < 0.0001$). Compliance improved for all persons entering the ward as follows (before – after, significance): doctors (0% – 54%, $P < 0.01$); nurses (24% – 75%, $P < 0.05$); porters (21% – 67%, $P < 0.05$); visitors (35% – 68%, $P < 0.01$); patients (23% – 44%, $P > 0.05$). There were two cases of MRSA bacteraemia in the initial 6 months and no cases in the following 6 months with the red line *in situ*.

CONCLUSIONS This study demonstrates how a simple intervention significantly improves hand-hygiene compliance with associated eradication of MRSA.

KEYWORDS

MRSA – Surgery – HCAI – Nosocomial – Infection – Handwashing

Accepted 23-1-10. Online publication 9-4-10

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Healthcare-associated infections (HCAIs) cost between £4000 and £10,000 per case, with an estimated cost of £1 billion per annum to the National Health Service in the UK.^{1,2} Methicillin-resistant *Staphylococcus aureus* (MRSA) is one such HCAI where the UK incidence exceeds many parts of Europe.^{3,4} MRSA is therefore a global healthcare issue with medical and socio-economic consequences for patients, healthcare professionals and hospital trusts. Patients have increased morbidity and mortality, whilst increasing lengths of stay and additional medical and surgical interventions lead to hospital trusts incurring further costs.^{5–8}

Poor hand hygiene is the main source of MRSA transmission within hospital.⁹ However, after applying alcohol gel, 99% of transient organisms, including MRSA, are eradicated.¹⁰ In an attempt to reduce the incidence of patients with

MRSA, hand-hygiene awareness has become more prominent world-wide.^{11,12} Research has also identified numerous other potential sources of MRSA within hospital. These include tourniquets,¹³ stethoscopes,¹⁴ marker pens,¹⁵ case notes,¹⁶ bed control handsets,¹⁷ nebulisers,¹⁸ ventilation grilles^{19,20} and environmental surfaces.²¹ Studies have proposed that healthcare workers may act as a vector for MRSA transmission.²² All persons entering a surgical ward may therefore act as an exogenous source of MRSA to susceptible patients, especially if hand-hygiene policies are not adhered to. It is therefore imperative for all persons entering a surgical ward to apply alcohol gel as a means of reducing nosocomial MRSA. The aim of this study was to quantify the compliance of alcohol gel application on entering a surgical ward. The primary outcome was to assess if a simple

Table 1 Compliance with applying alcohol hand gel on entering a surgical ward before and after intervention

Person entering ward	Before intervention		After intervention		P-value	Significance
	n	Compliance (%)	n	Compliance (%)		
Doctor	21	0	13	53.8	0.009	**
Nurse	21	23.8	8	75.0	0.028	*
Porter	28	21.4	6	66.7	0.048	*
Visitor	58	34.5	25	68.0	0.008	**
Patient	13	23.1	9	44.4	0.376	N/S
All persons	154	24.0	61	62.3	< 0.0001	***

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.0001$; N/S, not significant.

intervention at the ward entrance improved alcohol gel compliance for all persons entering the surgical ward over a 12-month period. Secondary outcomes included quantifying MRSA infection rates on surgical wards and assessing the relationship between compliance rates and the incidence of MRSA infection.

Subjects and Methods

From July 2007 to July 2008, doctors, nurses, porters, patients and visitors were observed as they entered a surgical ward via a discretely positioned close-surveillance camera at the ward entrance. The camera was covertly positioned in the corner of the ceiling behind the ward entrance, such that persons entering the ward were unable to see the device. Footage was reviewed and compliance data were collected for all persons entering the ward over a 6-month period. A simple intervention was then applied with the aim of improving alcohol gel application. The intervention consisted of a conspicuous strip of bright red tape along the corridor on the approach leading to the ward entrance. The red line continued up the wall to produce an arrow head pointing to the two alcohol gel dispensers on the wall. Adjacent yellow posters instructed the use of the gel for all persons before entering the ward. Compliance with alcohol gel was then re-assessed for a further 6 months using the same method.

Data collected included the job description of the person entering the ward and whether alcohol gel was applied. MRSA data were also collected using microbiological records for all in-patients on the ward during this 12-month period.

No other infection control practices were actively changed or promoted during the 12-month study period. The intervention described was, therefore, the only change that took place during the study period, thus allowing direct comparison of hand-hygiene practice before and after the intervention was *in situ*.

To act as a control, MRSA data were collected from a second ward that did not have a red line as an intervention during the 12-month period. This second ward was chosen on the basis of a similar case-mixture of surgical patients yet without a red-line directing persons to the alcohol gel dispenser.

Statistical analysis

Fisher's exact tests were used to compare compliance rates before and after the intervention. Significance was set at $P < 0.05$.

Results

A total of 215 persons were observed entering the surgical ward. Mean baseline compliance with alcohol gel application was 24% during the 6 months preceding the intervention (range, 0–34.5%; Table 1). Doctors were the worst offenders, with none of the 21 clinicians applying alcohol gel. Visitors to the ward

Figure 1 Compliance with applying alcohol gel at the surgical ward entrance before and after the intervention.

were the most compliant at 34.5%. After the red tape and signs were *in situ*, compliance with applying alcohol gel significantly increased for all persons entering the ward to 62.3% ($P < 0.0001$; Fig. 1). After separating individuals by job description, doctors, nurses, porters and visitors all significantly improved in their compliance after the red line was in position ($P < 0.05$). However, the improved compliance of patients from 23.1% to 44.4% failed to reach significance ($P = 0.376$). Doctors and visitors demonstrated the greatest improvement in compliance ($P < 0.01$), whilst nurses practiced the best compliance rates of all groups at 75% after the intervention.

There were two cases of MRSA bacteraemia on the ward during the initial 6-month period. During the second 6-month period – when the red line and signs were in position – there were no documented cases of MRSA bacteraemia on the ward.

On the control ward, where no intervention took place, there were no cases of MRSA in the initial 6 months, and two cases of MRSA in the second 6 months.

Discussion

This study has quantified compliance with applying alcohol gel at a surgical ward entrance without an intervention *in situ* at 24%. A simple intervention has been described that resulted in a sustained behavioural change that improved compliance to 62% for all persons entering the ward ($P < 0.0001$). These findings are in accordance with other studies that have implemented extensive hand-hygiene and infection control promotion programmes: compliance improved from 48% to 66% in a Swedish study¹¹ and from 21% to 41% in an Australian study.¹² However, despite reported improvements in practice, compliance levels are still below 100% and, therefore, sub-optimal, which may contribute to potentially preventable HCIs and as a result compromise the care patients receive.

Several theories may explain this apparent discrepancy in compliance between current and gold standard practice. First, healthcare professionals, visitors and patients may be unaware of hand-hygiene policies and inadvertently omit applying alcohol gel. This seems unlikely given extensive public and professional awareness campaigns to raise awareness of infection control practice.²³ Second, it is possible that healthcare professionals were intending to wash their hands inside the ward and, as such, felt it was unnecessary to apply alcohol gel at the ward entrance. Such practice may perpetuate the silent transmission of MRSA from hands to case notes,¹⁶ work surfaces²¹ and marker pens¹⁵ in the sequence of events preceding direct patient contact. Third, individuals may experience a skin reaction to the gel and, therefore, not wish to use alcohol gel. Fourth, in accordance with the Delphi principle, there may be a cohort of persons who disagree with alcohol gel as a means of hand decontamination and may choose to ignore occasional hospital guidelines. Doctors have been shown to be more averse to following standardised written rules than nurses

within the operating theatre²⁴ and may preferentially follow independent practice rather than formal written protocols.

It is important not only to improve hand hygiene compliance, but to sustain improvements to maintain high-quality healthcare practice. Sustained behavioural change may require a cultural change via a 'bottom-up' approach by targeting undergraduates. In 2006, 58% of UK medical students in Birmingham were unaware of the indications for applying alcohol gel.²⁵ However, 49% felt there was insufficient undergraduate teaching on infection control, which is encouraging for the infection control practice for future doctors, which shows that there may be potential for improvement with increased educational input. Other attempts to sustain good hand hygiene practice might include performance feedback,²⁶ improved multidisciplinary team unity²⁷ and senior clinicians leading by example.²⁸

Financially, nosocomial infections are costly and contribute significant outlay of hospital and trust funds. It is, therefore, important to find cost-effective solutions to combat HCIs. Given the cost of the intervention in this study was less than £1, and the cost of an HCAI is estimated to be £4000,⁴ this method is affordable for all hospitals world-wide. Furthermore, other studies highlight the direct relationship between the volume of alcohol gel used and reduced MRSA infection rates²⁹ in a dose-response manner.³⁰ In addition to promoting the frequency of alcohol gel application,³¹ it is also imperative that the most effective bactericidal alcohol gel is available on surgical wards and that it is applied correctly.^{32,33}

Other studies have investigated alternative approaches to improving hand-hygiene compliance.^{11,12} One such approach in Australia was to introduce a cultural change programme consisting of promotional events, computer-based educational packages and free T-shirts, and employed the services of advertising consultants and artists. Though successful – hand-hygiene compliance significantly improved from 21% to 41% – this concept required \$180,000 per year to be sustained.¹²

Study limitations

Limitations of this study include the low staff numbers entering the ward. However, the observations were carried out at different points in the day and night in order to obtain a representative range of data. There may also be confounding factors, such as the potential for concurrent infection control practices that may be responsible for the increase in hand-hygiene compliance. However, apart from the red line outlined in this study, there were no known additional interventions during the study period. Furthermore, the results of the control ward indicate that MRSA rates increased where there was no red line *in situ*, further reinforcing the likelihood that the results are a direct result of the intervention. Another potential confounding factor can be explained by the Hawthorne effect: was the improvement in compliance because of the red line, or because of the novelty of the audit? Given the fact that the red

line was in place over a period of 6 months, it is likely that the improvements in infection control practice are sustained behavioural changes rather than a transient response.

Conclusions

The ward entrance is a key point in the process of hand hygiene and infection control policy should be adhered to by all persons entering the ward. In addition to one's hands, which are the main source of transient MRSA carriage, objects carried by the majority of persons entering a ward, such as stethoscopes,¹⁴ mobile telephones³⁴ and identity cards,³⁵ may also harbour bacteria and act as external sources of MRSA. This further emphasises the ubiquity of potential sources of nosocomial infections, therefore supporting the need to apply alcohol gel at the ward entrance, irrespective of job description or purpose of visiting the ward.

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