

Reusable venesection tourniquets: a potential source of hospital transmission of multiresistant organisms

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The hospital environment can be a source of transmission of multiresistant organisms (MROs). Hospital infection control policies attempt to minimise cross-transmission of MROs, which include methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE), and Enterobacteriaceae harbouring transmissible extended-spectrum β -lactamases (ESBLs) and metallo- β -lactamases (MBLs). Surfaces such as keyboards,^{1,2} stethoscopes,^{3–6} ties,^{7–11} lanyards¹² and tourniquets^{1,13–15} have the potential to act as fomites and can harbour pathogenic microorganisms.

Reusable venesection tourniquets are often used consecutively on multiple patients without disinfection between uses. Current Australian health care guidelines suggest cleaning of these non-critical items with a neutral detergent on a regular basis.¹⁶ However, the required frequency of cleaning is not specified, nor whether this would prevent transmission of MROs to patients. Previous studies have indicated varying rates of MRO colonisation of reusable tourniquets, and differ based on the sensitivity of the culture method used.¹⁷ We performed this study to determine the prevalence of MRO colonisation of reusable venesection tourniquets in a Sydney teaching hospital using a sensitive enrichment method.

Methods

Hospital setting

The study was conducted at Concord Hospital, a 503-bed metropolitan teaching hospital in Sydney. Random sampling and testing of 100 reusable tourniquets took place over a 10-week period between September and November 2010. Tourniquets were randomly collected from locations throughout the hospital, including general wards, ambulatory care areas (defined as outpatient clinics, the

Abstract

Objective: To determine the prevalence of multiresistant organism (MRO) colonisation of reusable venesection tourniquets.

Design and setting: A prospective study in a tertiary hospital to collect and analyse reusable venesection tourniquets for the presence of MROs — methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE), and extended-spectrum β -lactamase and metallo- β -lactamase-producing Enterobacteriaceae — using a sensitive enrichment method. Tourniquets were collected and tested during a 10-week period between September and November 2010.

Main outcome measure: Prevalence of MRO colonisation of tourniquets.

Results: The overall colonisation rate of 100 tourniquets randomly collected from general wards, ambulatory care areas and critical care areas was 78%. MROs were isolated from 25 tourniquets collected from a variety of hospital locations, including general wards, the intensive care unit, burns unit and anaesthetic bay. MRSA was isolated from 14 tourniquets and VRE from 19; both MRSA and VRE were isolated from nine tourniquets. There were no microorganisms isolated from 22 tourniquets.

Conclusion: Reusable tourniquets can be colonised with MROs and may be a potential source of transmission of MROs to hospitalised patients.

blood collection unit, doctors' offices and the emergency department) and critical care areas (defined as the operating theatre, intensive care unit [ICU] and burns unit).

This study was organised by the hospital infection control committee as an investigation into tourniquet contamination and disinfection. As there were no patients involved and no patient specimens collected, ethics approval was not sought.

Microbiology

Reusable tourniquets were collected and immediately placed into a polyethylene specimen bag, labelled and transferred to the laboratory. At twice weekly intervals, tourniquets were immersed in an enrichment medium (Brain Heart Infusion Broth; Oxoid Australia, Adelaide, SA) and incubated overnight. Fluid from the broth was then subcultured onto a variety of agar media: horse-blood agar (Columbia HBA; Oxoid), MacConkey agar (Oxoid), and selective agar media for the detection of MRSA (MRSA-Select; Bio-Rad, Sydney, NSW), VRE (chromID VRE; bioMérieux, Sydney, NSW) and resistant gram-negative bacteria including ESBL- and MBL-

producing organisms (*Brilliance* ESBL Agar; Oxoid). Significant isolates were identified, and resistance gene testing was performed for the confirmation of MRSA, VRE and MBL resistance.

Growth of isolates from broth enrichment was recorded, and classified as: environmental organisms or bacteria of low pathogenic potential; "potentially significant" bacteria; and MROs (defined as MRSA, VRE, and MBL- and ESBL-producing Enterobacteriaceae). We typed VRE isolates using a DiversiLab rep-PCR system (bioMérieux). Tourniquets that tested positive for MROs or other potentially significant organisms were discarded.

Results

Tourniquet collection data are summarised in Box 1. The majority of tourniquets were collected from areas where they are frequently used, such as the blood collection unit ($n=7$), and from general medical and surgical wards. Bacteria were isolated from tourniquets collected in every week of the study period. The overall bacterial colonisation rate of the 100 tourniquets was 78%. There was no bacterial growth from 22 tourniquets, and

17 grew only environmental organisms or bacteria of low pathogenic potential (coagulase-negative staphylococci and/or *Bacillus* spp).

Microbial colonisation data are summarised in Box 2. Many tourniquets were colonised with more than one organism. Ten grew potentially significant gram-positive organisms (methicillin-sensitive *Staphylococcus aureus* or *Enterococcus* spp), and 38 grew potentially significant gram-negative organisms (*Pseudomonas* spp and/or Enterobacteriaceae).

MROs were found on 25 tourniquets; however, three had been collected from MRO isolation rooms. An IMP-4 MBL-positive *Enterobacter cloacae* and an ESBL-positive *E. cloacae* were each isolated from a single tourniquet. MRSA was isolated from 14 tourniquets. VRE was isolated from 19 tourniquets: *vanB*-positive *Enterococcus faecium* from 18, and *vanA*-positive *Enterococcus faecalis* from one. Nine tourniquets isolated both MRSA and VRE, and 24 grew one or the other of these. Typing of the 18 *vanB*-positive isolates demonstrated five VRE clusters (Box 3). There was no apparent association between clusters of enterococci and hospital location.

Six of nine tourniquets collected from the ICU throughout the study period grew at least one MRO, although two had been used on patients known to be colonised with MRSA. MROs were isolated from tourniquets collected in most weeks of the study period (Box 1) from various hospital locations, including general wards, the ICU, burns unit, operating theatre anaesthetic bay, and the blood collection unit. The ICU had the highest rate of MRO colonisation (67% [6/9] v 23% [15/64] in wards and 13% [3/23] in ambulatory care areas).

Discussion

We found that 61% of reusable tourniquets were colonised with bacterial species that would not be considered normal upper-limb skin flora and that can be associated with hospital-acquired bacteraemia. A quarter of randomly collected tourniquets yielded an MRO. If a single patient MRO transmission is perceived to be

1 Tourniquets sampled from each location, by most clinically significant category of bacteria isolated

	Week										Total
	1	2	3	4	5	6	7	8	9	10	
Wards											
No bacterial growth	0	1	2	3	1	1	3	2	0	0	13
Environmental or low pathogenic potential organisms	0	2	0	2	0	2	1	1	2	1	11
Potentially significant non-MROs	0	5	3	3	1	5	3	3	2	0	25
MROs	0	0	1	3	1	4	4	1	1	0	15
Ambulatory care areas*											
No bacterial growth	0	1	1	0	4	0	0	2	0	0	8
Environmental or low pathogenic potential organisms	2	0	0	0	0	0	1	0	0	0	3
Potentially significant non-MROs	0	3	0	0	4	2	0	0	0	0	9
MROs	1	1	0	0	0	1	0	0	0	0	3
Critical care areas†											
No bacterial growth	0	0	0	0	0	0	0	1	0	0	1
Environmental or low pathogenic potential organisms	0	1	0	0	0	0	1	0	0	1	3
Potentially significant non-MROs	0	1	0	0	0	0	0	1	0	0	2
MROs	0	1	3	1	1	0	0	0	1	0	7
Total tourniquets	3	16	10	12	12	15	13	11	6	2	100

MROs = multiresistant organisms. * Emergency department, outpatient clinics, blood collection unit and doctors' offices.
† Operating theatre, intensive care unit and burns unit. ◆

2 Microbial colonisation of tourniquets*

Organism	Wards	Ambulatory care	Critical care	Total
Total tourniquets collected	64	23	13	100
Environmental or low pathogenic potential				
Coagulase-negative staphylococci	10	2	1	13
<i>Bacillus</i> spp	37	9	8	54
Potentially significant non-MROs				
<i>Enterococcus</i> spp	7	2	0	9
Methicillin-sensitive <i>Staphylococcus aureus</i>	1	0	0	1
Enterobacteriaceae	15	9	2	26
<i>Pseudomonas</i> spp	12	6	0	18
MROs				
Methicillin-resistant <i>Staphylococcus aureus</i>	6	2	6	14
Vancomycin-resistant enterococci	10	3	6	19
Extended-spectrum β -lactamases	0	0	1	1
Metallo- β -lactamases	1	0	0	1

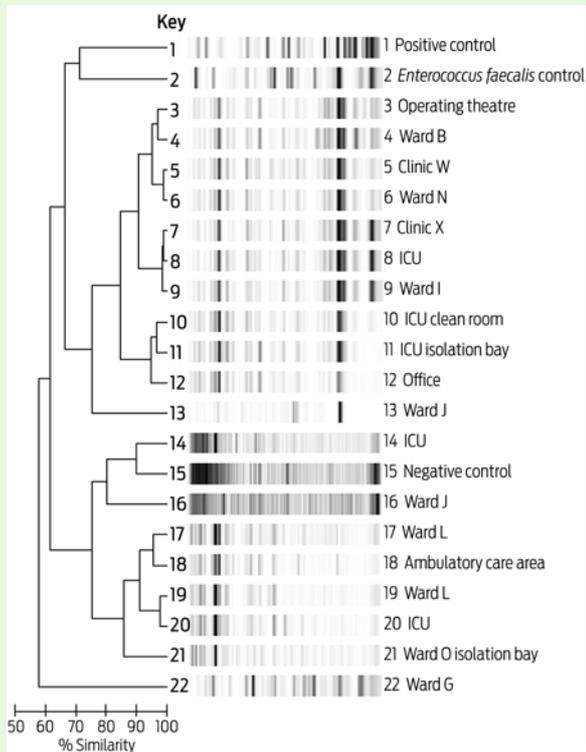
MROs = multiresistant organisms. * Many tourniquets had mixed bacterial growth. ◆

an avoidable patient care outcome, then any reuse of MRO-colonised tourniquets may present an unacceptable risk.

It is estimated that around 6% of hospitalised patients will acquire an infection during their admission, leading to increased length of stay, further treatment and higher overall cost.¹⁸ To what extent tourniquets contribute to colonisation, and possibly bacteraemia, is uncertain. MRO colonisation of tourniquets may

reflect the burden of MROs in the wider hospital environment and provide a measurable index of the level and quality of hospital environmental hygiene. Tourniquets may have higher potential for MRO transfer than other fomites as they are applied under pressure against the patient's skin. They are also placed in close proximity to vascular access sites, and any skin colonisation could lead to preventable complications or health care-associated infections, such as phlebitis or

3 Typing of vancomycin-resistant enterococci isolates from tourniquets*



ICU = intensive care unit. * Typing of 18 *vanB*-positive isolates shows five predominant clusters obtained from several locations within the hospital. ◆

cannula site infections. It is untenable that patients are exposed to potentially virulent pathogens on reused equipment.

While disposable tourniquets are readily available, their use is not universal due to perceived difficulties in application and patient discomfort. However, a study found that 85% of patients found disposable tourniquets at least as good as reusable tourniquets, and 95% of doctors found them as easy to use.¹⁹ With adequate training provided, and at a cost of about 50 cents per unit (BD, Sydney, NSW), disposable tourniquets are a viable alternative for preventing acquisition of MROs in the hospital environment. However, there is currently no supporting evidence that introducing disposable tourniquets reduces hospital MRO acquisition rates. Moreover, such a measure should be one element of a bundle of infection control measures implemented to improve hospital environmental hygiene, and hence it may be difficult to measure its contribution to reduced MRO rates.

While previous studies have demonstrated MRSA colonisation rates ranging between 0 and 42%,¹⁶ none have reported rates of VRE colonisation. We also identified colonisation by multiresistant gram-negative organisms with transmissible β -lactamase enzymes, including IMP-4. The presence of such enzymes can result in infections that are virtually untreatable with available antibiotics. These have previously been shown to be transmitted readily throughout the hospital environment.²⁰

We found that the highest rate of colonisation of MROs was in the ICU. ICUs are recognised as hospital sites with high throughput of patients and staff, and with resultantly higher acquisition rates and difficulty in controlling transmission of MROs. We found that VRE clusters isolated from tourniquets in the ICU did not appear to be clonally related, reflecting the complex pattern of movement of staff, patients and tourniquets within the hospital. Tourniquets in the ICU in this study were allocated for single patient use, which demonstrates that MRO colonisation was not necessarily due to reuse, but that deficiencies in hospital environmental hygiene are likely to contribute to ongoing MRO colonisation of tourniquets in the ICU. Although several tourniquets were obtained from isolation rooms that accommodated patients already colonised with an MRO, and may therefore reflect the patient's own flora, the majority had been used on patients whose screening had not identified MRO colonisation.

MROs may remain viable in the environment for a long time, as demonstrated by an MRO-colonised tourniquet (collected from an office) that had not been used for several months. When tourniquets are carried from ward to ward by hospital staff and used repeatedly, they may become a "sleeper" mechanism for unrecognised hospital MRO transmission. Of concern were the nine tourniquets that were colonised with both MRSA and VRE. This probably reflects a baseline prevalence of co-colonisation of 20%.²¹

A limitation of our study is that data on tourniquet use could not be collected. Previous studies have surveyed health care personnel about hand

hygiene practices and glove and tourniquet use.²² The tourniquets sampled in our study were shared among multiple users and may have been used in many different hospital wards. However, this reflects the hospital's day-to-day practice of tourniquet use. There was no way of tracking how often the tourniquet had been used, or where MRO acquisition had occurred. A British study demonstrated that contamination of tourniquets could be attributed to the user's hands rather than the patient's skin.²³ We hypothesise that MRO colonisation of tourniquets can also be acquired from the surrounding hospital environment. The random hospital locations of the VRE clusters we recovered lends some anecdotal support to this hypothesis. A study examining colonisation of surfaces where tourniquets are stored may resolve this issue.

In this study, we did not culture for *Clostridium difficile*, which requires specialised media and incubation conditions to detect. *C. difficile*-associated diarrhoea can cause significant morbidity and mortality in hospitalised patients, and it is known that its spores may survive for a long time in the environment.

Previous studies¹⁶ have determined the limit of detection and performed semi-quantitative bacterial counts for MROs.²³ Our study used a broth enrichment method, which may have increased sensitivity compared with methods used in previous studies, and we felt it was sufficient to demonstrate viability of bacteria from tourniquets using this method.

Reducing the burden of hospital-associated infections is being addressed through multifaceted approaches such as hand hygiene and antimicrobial stewardship programs. As reusable tourniquets are frequently colonised with MROs and may be a source of cross-transmission, the burden of MRO colonisation from the hospital environment also needs to be considered. With current high prevalence rates of MROs, continued use of reusable tourniquets may not be justified in the hospital setting.

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