Quantifying patient bacterial exposure risk from reusable phlebotomy tourniquets in a New Zealand secondary level hospital

Journal of Infection Prevention
2015, Vol. 16(6) 262–265
DOI: 10.1177/1757177415600242
© The Author(s) 2015
Reprints and permissions:
sagepub.co.uk/journalsPermissions.nav
jip.sagepub.com

Cameron KMW Schauer¹ and David A Hammer²

Abstract

Aim: This study aimed to assess for the presence of multi-drug resistant organisms (MDROs) on tourniquets and quantify the number of bacteria to which patients might be exposed with each blood collection episode.

Methods: Tourniquets were randomly sampled in a 246-bed, secondary level, New Zealand hospital, which is currently non-endemic for MDROs. A 6-cm length of each tourniquet sampled was applied to the surface of an agar plate and the colony forming units (CFUs) were enumerated. All colonies were then screened for MDROs using standard methods. CFU counts per linear centimetre were multiplied by a range of patient arm circumference measurements. Comparison was also made between non-disinfected tourniquets left on the wards and phlebotomy service tourniquets after daily decontamination with a proprietary disinfectant.

Results: The median exposure risk from non-disinfected tourniquets was 173 CFUs per collect (95% CI, 104–861). None of the general ward tourniquets grew any MDROs but four out of five dedicated, single-patient reusable isolation room tourniquets grew MRSA. Disinfected tourniquets had few if any CFUs and CFU counts were significantly lower than non-disinfected tourniquets ($P = 0.0001$).

Conclusion: The quantitative risk from reusable tourniquets appears low in the setting of MDRO non-endemicity, with the application of standard infection control practices.

Keywords

MDRO, MRSA, nosocomial infection, tourniquets

Background

The transmission of multi-drug resistant organisms (MDROs) within hospitals is a global concern. Various potential vectors of transmission have been studied including pens, keyboards, stethoscopes, lanyards and blood pressure cuffs. Venepuncture involves the high pressure application of a tourniquet near the vascular access site. This is often done in combination with poor hand hygiene and glove utilisation (Sacar et al., 2006). Studies of phlebotomy tourniquets have demonstrated a 25% contamination rate with MDROs (Leitch et al., 2006; Pinto et al., 2011), however, these reports are from large, urban hospitals with apparently high levels of MDRO. Some authors now recommend that reusable tourniquets be abandoned

and disposable ones become the standard of care to prevent infection risk (Elhassan and Dixon, 2012). It is our experience, however, that reusable tourniquets are preferred by many staff and tend to be more comfortable for patients.

¹Department of General Medicine, Whangarei Hospital, Whangarei, New Zealand.

²Department of Microbiology, Northland District Health Board Laboratory Services, Whangarei Hospital, Whangarei, New Zealand.

Corresponding author:

Cameron Schauer, C/O RMO Unit, Private Bag 9742, Whangarei, 0110, New Zealand.
Email: cameron.schauer@gmail.com

This study was undertaken in order to inform the decision on whether or not to change to only disposable tourniquets. Given that it would be exceedingly difficult to accurately measure infection transmissions from venepuncture events, we aimed to generate a simple model of the likely numbers of bacteria and MDROs that patients might be exposed to with each tourniquet application.

The primary aim of our study was to determine the local prevalence of MDRO carriage on phlebotomy tourniquets in various ward settings. Secondary objectives included calculating the theoretical number of bacterial colonies that patients are exposed to from tourniquets and comparing differences in bacterial numbers on used tourniquets depending on whether they were disinfected or not and by general ward areas versus MDRO isolation rooms. Finally, a direct cost comparison was carried out to model the costs of disposable versus reusable tourniquets.

Hospital setting

The study took place in Whangarei Hospital, a 246-bed, secondary level hospital in New Zealand. A wide variety of services are provided including general medicine, renal dialysis, rehabilitation medicine, general surgery, orthopaedics, otorhinolaryngology, obstetrics and gynaecology, paediatrics, mental health and outpatient oral health, ophthalmology and oncology.

The hospital is currently non-endemic for MDROs. Surveillance work done by both the laboratory and Infection Prevention and Control services have detected sporadic cross-transmissions of MDROs within the hospital but no sustained transmission events. Approximately 10% of *Staphylococcus aureus* strains isolated are MRSA. Vancomycin resistant enterococci (VRE) are rarely encountered. Although extended spectrum beta-lactamases (ESBLs) are increasingly encountered, monitoring work to date has indicated that only a minority are hospital-acquired.

The hospital has an accredited Infection Prevention and Control department which is actively involved in, among others, policy development, audit, surveillance and education. The hospital participates in the Hand Hygiene New Zealand programme based on the World Health Organization's 'My Five Moments for Hand Hygiene'. Of particular relevance, patients identified as carrying MDROs are isolated in a single room with a dedicated, single patient reusable tourniquet which is disposed of when the patient is discharged. Also, phlebotomists – who perform once daily blood collection ward rounds – follow standard hand hygiene protocols and clean their tourniquets between patients with Isowipes (Kimberly-Clark, 42 × 14cm, 70% v/v Isopropyl alcohol impregnated). At the end of each day, tourniquets used by phlebotomists are disinfected with a proprietary multi-agent disinfectant solution, Trigene (Medichem International Ltd., UK). A fresh solution is prepared each day, following the manufacturer's instructions. Tourniquets are soaked in this

solution for a minimum of 6 h then air-dried. These tourniquets are referred to in our study as 'disinfected' tourniquets. Tourniquets left on wards and in the emergency department for use by other healthcare practitioners are, insofar as we have been able to determine, not routinely disinfected and rely on the user for decontamination. The reusable tourniquets are supplied by central stores and are the same across the hospital.

Methods

Following local ethics committee approval, tourniquets in all ward areas were counted and then numbered consecutively to form a sampling frame. Ward staff were not aware of this. A computerised random number generator was used to select tourniquets for sampling. This was carried out over a 4-month period by a single investigator. Sampling included six tourniquets in the emergency department and five in MDRO isolation rooms. Comparison was also made between these non-disinfected tourniquets left on the wards and phlebotomy service tourniquets both before and after daily disinfection.

In order to physically simulate the risk of the tourniquet to skin exposure as closely as possible, a direct contact culture approach was used in preference to soaking the tourniquet in enrichment broth. The area of the tourniquet most likely to be in contact with the patient's skin (starting 1 cm from the buckle) was pressed lengthwise across the diameter of a sheep blood agar plate, using aseptic technique. The tourniquet was replaced after being marked, so that it could be later disposed of if MDROs were identified.

Microbiological investigations

The sheep blood agar plates (Fort Richard, NZ) were incubated aerobically with CO₂ enrichment at 37°C and then inspected at 48 h. Colony forming units (CFUs) were counted within a demarcated 6 cm length (3 cm either side from the centre-point of the impression). All the colonies were then swabbed and vortexed into 5 mL of sterile saline for MDRO subculture.

Chromagar plates (Fort Richard, NZ) were used to detect methicillin-resistant *Staphylococcus aureus* (MRSA) and ESBL-producing *Enterobacteriaceae*. VRE were sought using a proprietary VRE broth (Fort Richard, NZ). Any MDRO isolate identities were confirmed using standard methods and the sensitivities were checked using standard Clinical and Laboratory Standards Institute-based disc testing, with assistance from the laboratory's microbiology staff.

In order to estimate the average patient arm circumference, one inpatient ward was randomly chosen. After a brief explanation of the study and obtaining their verbal consent, all 25 patients' bicep circumferences were each measured twice. The measuring tape was cleaned with an

Table 1. Colony forming units (CFUs) per linear cm and total CFUs per venesection.

Tourniquets	No. tested	CFU per linear cm	CFUs per venesection
Source		Median (95% CI)	Median (95% CI)
General Wards	20	3.67 (1.33–6.17)	115 (38–212)
Emergency Department	6	5.5 (0.67–19.67)	173 (19–677)
Isolation Room	5	9.67 (1.17–13.33)	303 (33–459)
Phlebotomist trolley post Ward Round	6	11.67 (1.5–21.5)	366 (43–740)
Overall (non-disinfected)	37	5.5 (3.67–25.00)	173 (104–861)
After overnight disinfection	6	0 (0.00–0.17)	0 (0–6)

Isowipe and allowed to dry between uses. To estimate the range of bacterial numbers that patients are potentially exposed to with each venepuncture, the number of CFUs per linear centimetre of tourniquet was calculated and the median and 95% confidence rank limits were multiplied by the median and 95% confidence limits of the bicep circumference measurements.

Costs of tourniquet types, Isowipes and disinfectant were obtained from the hospital stores and number of blood collections per annum estimated from laboratory data. The number of admissions per year was obtained from the management information system.

Statistical analysis

The minimum sample size was determined using the standard equation for calculating the sample size for a mean: $n > (z^2 \times SD^2)/e^2$, where n is the number of samples, z is 1.96 for a 95% confidence interval, SD the standard deviation (estimated from pilot work as 50 colonies) and e the acceptable size of the error, which was taken to be within 20 colonies of the mean. The bicep circumference sample size was simply selected as the number of patients on a ward selected at random.

StataCorp 2011 (Stata Statistical Software: Release 12, Statacorp LP, College Station, TX, USA) and Microsoft Excel 2010 were used for statistical analysis. As the CFU count sample numbers were small and the data were non-symmetrically distributed, non-parametric methods were used. Wilcoxon rank-sum was used for comparison between tourniquet groups.

Results

The sample size calculation suggested that more than 24 samples would be required. The predominant growth from the 37 non-disinfected tourniquets was consistent with normal skin flora. No ESBL-producing *Enterobacteriaceae* or VRE were detected. Four of the five tourniquets from isolation rooms, however, were positive for MRSA. Two of

these were non-multiresistant MRSA – being resistant to two or less non beta-lactam antibiotics (Munckhoff et al., 2008). Two were found to be multiresistant MRSA and were sent for spa-typing, molecular sequencing of the staphylococcal protein A region. Both spa-typed as t008 (USA300), a relatively new strain in our region, which matched the isolated patients' strains. The non-multiresistant strains susceptibility patterns matched the other two patients' strains.

The median adult arm circumference was 31 cm (95% confidence interval [CI], 28.3–34.4). The numbers of CFUs per linear cm by ward area and total bacterial exposures per venesection episode are depicted in Table 1. The largest density of colonies was found on the tourniquets used for phlebotomist ward rounds prior to overnight disinfection (median, 11.67; 95% CI, 1.5–21.5), followed by isolation rooms (median, 9.67; 95% CI, 1.17–13.33). Overall, tourniquets sampled after they had undergone overnight disinfection had a statistically significant lower bacterial count than those that had not (Wilcoxon rank-sum, $P = 0.0001$). There was no significant difference between the non-disinfected subgroup CFU counts.

A cost comparison analysis showed that moving to disposable tourniquet use would be roughly equivalent in overall cost to the status quo of non-disposable tourniquet use (approximately NZ\$ 14,500 per year, including tourniquets, wipes and disinfectant). Issuing each patient their own dedicated reusable tourniquet would cost nearly NZ\$ 330,000 per year.

Discussion

Insofar as we are aware, this is the first study to review quantitative bacterial counts from tourniquets. We used a contact plate approach to simulate the likely numbers of bacteria transferred with each tourniquet use. When the tourniquet is left without routine disinfection, a patient can expect to be exposed to a median of 173 CFUs during a blood collection, none of which represent MDROs. This compares to an average of 52 CFUs identified on the

imprint of the five fingertips of a healthcare worker's dominant hand after hand washing (Pittet et al., 1999). We therefore consider that, in terms of the number of bacteria, the average tourniquet exposure risk is in the same order of magnitude as that of the patient being handled with clean hands. In the general setting, bacteria isolated in our study appeared to be of low pathogenicity. As could have been anticipated, growth was almost entirely consistent with normal skin flora and no ESBLs were detected. The lack of ESBLs could be a result of the dry environment of the tourniquet or merely a reflection of the typical flora of the upper arm. This model generated by the study suggests that the overall risk of nosocomial infection from reusable tourniquets appears low in our hospital. It also established that disinfecting tourniquets with Trigene is an effective method for reducing bacterial counts.

Limitations of this study included the relatively small sample size, however, the number of tourniquets sampled represented over 20% of the identified total number in the hospital. The study's findings are very unlikely to apply to other hospitals that are in MDRO endemic situations. We did not attempt to formally identify bacteria that were not MDROs, as some studies have done (Pinto et al., 2011). Although the colonies appeared to be normal skin flora, it is feasible that some of the bacteria could have included potential non-MDRO nosocomial pathogens. The study was not blinded as this was not considered necessary for the simple task of counting colonies. Ward tourniquets would have varied in time between use and sampling, however, the randomisation was intended to reduce this potential confounder. We also did not measure bacterial contamination of tourniquets cleaned with Isowipes between patients on phlebotomy rounds and would, therefore, not have detected potential fluctuations in bacterial count and resistance during the rounds if the isopropyl alcohol had not had the desired effect. The simple cost analysis was only a direct comparison of product and disinfectant costs and did not take into account potential costs from a nosocomial infection.

Strengths of this study included that every ward area within the hospital was sampled. We believe that the method of pressing the tourniquet against the blood agar best modelled a patient's potential exposure risk from tourniquet application although this may have resulted in lower bacterial counts than the liquid immersion methods utilised in other material contamination studies. Staff handling the tourniquets were unaware of this study, which prevented any changes or alterations in usual tourniquet handling. Randomisation of tourniquet sampling prevented selection bias. Consistency of method application by only a single investigator avoided inter-observer variability.

In our current setting of MDRO non-endemicity, with the application of standard infection control practices, it would appear both epidemiologically and economically viable to continue with reusable tourniquets.

Acknowledgements

We thank the NDHB Microbiology Laboratory Scientists for their assistance and the ESR Nosocomial Infections Laboratory, Kenepuru, Wellington for spa-typing the MRSA strains.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Peer review statement

Not commissioned; blind peer-reviewed.

Ethics

Approved by the Whangarei Hospital Ethics Locality Assessment Committee.

Author note

Research presented as poster 1119 at the International Union of Microbiological Societies Conference, Montreal, July 2014.

References

- Elhassan HA and Dixon T (2012) MRSA contaminated venepuncture tourniquets in clinical practice. *Postgraduate Medical Journal* 88(1038): 194–197.
- Leitch A, McCormick I, Gunn I and Gillespie T (2006) Reducing the potential for phlebotomy tourniquets to act as a reservoir for methicillin-resistant *Staphylococcus aureus*. *Journal of Hospital Infection* 63(4): 428–431.
- Munckhof WJ, Nimmo GR, Carney J, Schooneveldt JM, Huygens F, Inman-Bamber J, Tong E, Morton A and Giffard P (2008) Methicillin-susceptible, non-multiresistant methicillin-resistant and multiresistant methicillin-resistant *Staphylococcus aureus* infections: a clinical, epidemiological and microbiological comparative study. *European Journal of Clinical Microbiology & Infectious Diseases* 27(5): 355–364.
- Pinto AN, Phan T, Sala G, Cheong EY, Siarakas S and Gottlieb T (2011) Reusable venesection tourniquets: a potential source of hospital transmission of multiresistant organisms. *Medical Journal of Australia* 195(5): 276–279.
- Pittet D, Dharan S, Touveneau S, Sauvan V and Perneger TV (1999) Bacterial contamination of the hands of hospital staff during routine patient care. *Archives of Internal Medicine* 159(8): 821–826.
- Sacar S, Turgut H, Kaleli I, Cevahir N, Asan A, Sacar M and Tekin K (2006) Poor hospital infection control practice in hand hygiene, glove utilization, and usage of tourniquets. *American Journal of Infection Control* 34(9): 606–609.