Potential Risk of Cross-Infection by Tourniquets: A Need for Effective Control Practices in Pakistan

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ABSTRACT

Background: Tourniquets used repeatedly on patients for blood sampling are a potential source of nosocomial infections. They harbor numerous microorganisms, including methicillin-resistant *Staphylococcus aureus* (MRSA). The aim of this study was to investigate tourniquets for the presence of microorganisms and to ascertain the infection control practices of health care workers.

Methods: A cross-sectional study was carried out in 2012 on 100 samples of tourniquets collected from public and private sector hospitals in Karachi, Pakistan. The samples were cultured, and pathogenic microorganisms were identified and tested for methicillin resistance. A questionnaire was administered simultaneously to 100 health care workers who had used the tourniquets. Descriptive data are represented as frequencies and percentages. Ethical considerations were taken into account.

Results: The total colonization rate was 51%, with no bacterial growth in 17/40 and 32/60 samples from public and private sector hospitals, respectively. *S. aureus* was isolated from 12 (42%) private sector hospital samples and 10 (43%) public sector hospital samples. Although MRSA was found in more samples from public than private sector hospitals, the difference was not statistically significant. Nevertheless, 90% of all elastic and 41% of all rubber tourniquets harbored microorganisms ($P < 0.001$). Although 96% of health care workers agreed that hospital staff and fomites can transmit infection, none identified tourniquets as a potential source. When asked whether tourniquets appeared clean before use, 66% agreed, and only 25% considered that tourniquets should be washed or cleaned before use.

Conclusions: Tourniquets are a potential reservoir and vehicle for the spread of nosocomial infections, including MRSA. Health care workers have inadequate knowledge about infection control procedures and personal hygiene for disinfecting reusable items.

Keywords: Fomite, health care worker, infection, nosocomial infection, tourniquet

Original Article

INTRODUCTION

Health care workers can be a source of hospital-acquired

infections to patients,[1] either as vectors themselves or by disseminating infections through fomites such as white coats,[2] mobile phones,[3] stethoscopes,[4,5] and intravenous catheters.[6] Infection transmission rates can be significantly reduced by preventive strategies such as hand hygiene.[7,8] However, awareness and practice of infection control are generally lacking throughout the health care system in Pakistan,[9] and the standard is especially poor in the public sector hospitals, due mainly to limited resources and high patient volumes mostly from lower socioeconomic strata. Moreover, infection control policies are not in place, nor is there a system for monitoring and quantifying the incidence of health care-related infections in either public or private sector hospitals.[9]

Hospital-acquired infections can lead to increased length of stay and higher costs;[10] however, tourniquets have not been evaluated in this context. They may have a higher potential for transferring microorganisms than other fomites as they are applied under pressure against the patient's skin; they may also cause phlebitis and associated infections. Previous studies have also indicated that tourniquets may act as reservoirs of pathogenic organisms and could therefore pose a risk to patients through cross-infection.[7,11-13]

In Pakistan, venous blood sampling and intravenous cannulation are the most common invasive procedures in hospitals, both of which involve the application of a rubber or elasticized cloth tourniquet around the patient's upper arm. Tourniquets are often used consecutively on multiple patients, regardless of their infective status and with no disinfection between uses, although the World Health Organization,[14] the National Association of phlebotomists in England[15] and Australian Healthcare guidelines[16] recommend that tourniquets and other noncritical items be cleaned between uses. Numerous studies have indicated reusable venesection tourniquets as a potential source of significant bacterial colonization and multi-resistant Gram-positive species.[12,17-19]

Methicillin-resistant *Staphylococcus aureus* (MRSA) is one of the most epidemiologically important antibiotic-resistant pathogens that cause hospital-acquired infections.[20] The main aim of this study was to investigate the use of reusable tourniquets as a potential source of pathogenic microorganisms and especially MRSA. We also assessed the practices of health care workers in infection control relating to tourniquet use.

METHODS

Study design and participants

This cross-sectional study was performed in 2012 in Karachi, Pakistan. Swabs were taken randomly during a 3-month period (June 1-August 31, 2012) from 100 tourniquets (40 in public and 60 in private hospitals) used in general wards, operating theatres, dialysis units, and casualty (emergency) departments. During the collection of the samples, the 100 health care workers, including junior doctors, nurses, and para-medical staff including laboratory phlebotomists who were using the tourniquets, were asked to respond to a survey questionnaire. Two incomplete questionnaires were rejected; the remaining health care workers were informed about the study. Ethical approval for the study was obtained from the Hamdard College of Medicine and Dentistry. The anonymity of the hospitals and medical and para-medical staff was assured.

Assessment of contamination

All tourniquets used when drawing blood, whether stained with blood or not, irrespective of type (elastic, plastic, or rubber), were sampled. Pneumatic tourniquet cuffs and tourniquets that were torn, disposable, not in use or used exclusively in hospital laboratories were excluded. To obtain the samples, swab sticks moistened with sterilized saline were rotated over both sides of the tourniquet at the distal and proximal ends, which are those most frequently touched by contaminated fingers. The samples were transported immediately in Amies transport media to the laboratory and streaked onto basic blood agar and MacConkey's agar culture medium (Oxoid Ltd., Basingstoke, Hampshire, England). Blood agar contains 15.0 g/L protease peptone, 2.5 g/L liver digest, 5.0 g/L yeast extract, 5.0 g/L sodium chloride and 12.0 g/L agar 12.0; and MacConkey's agar contains 17.0 g/L peptone for casein, 5.0 g/L sodium chloride, 10.0 g/L lactose, bile salt mixture, 0.03 g/L neutral red, 0.001 g/L crystal violet, and 13.5 g/L Agar. The

agar plates were incubated at 37°C for 24-48 h. Organisms showing growth after incubation were further processed for identification by Gram staining, morphology and biochemical tests such as with catalase, indole, Simmons citrate, urease, and oxidase.[21] Sensitivity to antibiotics was tested by the Kirby-Bauer disc diffusion method. A disc of methicillin (30 μg) was placed on a Mueller Hinton agar plate, which was then incubated at 37°C for 24-48 h, and the zone of inhibition was measured.

Statistical analysis

Data were entered, cleaned, and analyzed with SPSS 18 software (IBM Corporation). Descriptive data are reported as frequencies and percentages. Cross-tabulations were performed between the presence of microbial growth and public and private sector hospitals, and the Chi-square test was used for analysis of categorical variables where appropriate. Fisher's exact test was used when the expected value was < 5. $P < 0.05$ was considered to be statistically significant.

RESULTS

Microbiological investigations

Of the 100 samples collected from tourniquets, 51 had bacterial colonies. Bacterial growth was found on 23/40 samples from public sector hospitals and on 28/60 from the private sector hospitals. MRSA was more prevalent in public than in the private sector hospitals (18.2% vs. 16.6%, respectively), but the difference was not statistically significant [Figure 1]. *S. aureus* was isolated from 12 samples taken in the private sector hospitals and 10 taken in the public sector hospitals. One sample from a public sector hospital had *Staphylococcus epidermis* [Table 1]. Microorganisms were detected on 18/20 (90%) samples of elastic tourniquets and only 33/80 (41%) of rubber tourniquets ($P < 0.001$) [Table 2].

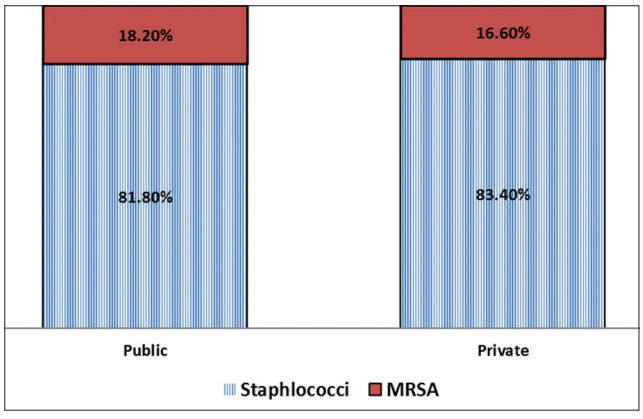

Figure 1: Proportion of methicillin-resistant *Staphylococcus aureus* in public and private sector hospitals

Questionnaire survey

Of the 98 participants, 51 were male and 47 were female, with a mean age of 25.6 ± 4.52 years. Two thirds of the participants had a graduate degree, and 60% had work experience of < 3 years (mean, 2.7 ± 2.64).

The majority (96%) of the health care workers agreed that hospital staff and fomites can transmit infection, but none of them identified tourniquets as a potential source. The fomites identified included sharps (32%), linen (36.4%), and stethoscopes (4.5%); only 43 (44%) agreed that tourniquets could be a source of infection. Twenty seven percent agreed that the tourniquets were always or sometimes blood-stained. Two-thirds said that tourniquets appeared to be clean before use, and only 25% agreed that they should be washed or cleaned before use [Table 3].

Table 1: Microorganisms found on samples from public and private sector hospitals

Microorganism	Hospital (%)		*P* value
	Public	Private	
Staphylococcus aureus	10 (43.4)	12 (42.8)	0.73
Staphylococcus epidermis	1 (4.3)	0	0.40*
Bacillus spp.	10 (43.4)	6 (21.4)	0.08
Klebsiella spp.	0	10 (35.7)	<0.01*
Escherichia coli	1 (4.3)	0	0.40*
Fungi	1 (4.3)	0	0.40*

*Fisher exact test

Table 2: Presence of microbial growth and type of hospital and tourniquet

Variable	Microbial growth (%)		*P* value
	Present	Absent	
Type of hospital			
Public (*n*=40)	23 (57.5)	17 (42.5)	0.28
Private (*n*=60)	28 (46.6)	32 (53.3)	
Type of tourniquet			
Rubber/plastic (*n*=80)	33 (41.2)	47 (58.7)	<0.001
Elastic (*n*=20)	18 (90.0)	2 (10.0)	

Table 3: Demographics, perceptions and practices of tourniquet use by health care workers

Variable	*N* (total=98)	Percentage
Sex		
Male	51	52
Female	47	48
Age (years)		
18-24	36	36.7
25-30	57	58.2
≥31	05	5.1
Mean (SD)	25.61±4.52	
Experience (years)		
1-2	59	60.2
3-5	33	33.7
>5	06	6.1
Mean (SD)	2.72±2.64	
Hospital staff or fomites can transmit infection to patients		
Yes	94	95.9
No	04	4.1
Potential sources of fomites for transmitting infection*		
Stethoscopes	13	4.5
Sharps	93	32
Linen (bed sheets, clothing and dressings)	106	36.4
Other (hands, instruments, patients' belongings)	79	27.1
Can tourniquets be a source of infection?		
Yes	43	43.9
No	37	37.8
Sometimes	16	16.3
Do not know	02	2.0
Do tourniquets appear clean before use?		
Yes	65	66.3
No	09	9.2
Sometimes	17	17.3
Never noticed	07	7.1
How often are tourniquets blood-stained?		
Always	05	5.1
Sometimes	22	22.4
Never	54	55.1
Not noticed	17	17.3
Do you clean or wash tourniquets before using them?		
Yes	24	24.5
No	24	24.5
Sometimes	30	30.6
Never	20	20.4

*More than one response was allowed. SD=Standard deviation

DISCUSSION

In this study, reusable tourniquets with visible bloodstains were found to be potential fomites, harbouring *S. aureus*. Thus, 40% of the samples had *S. aureus* or MRSA. Although numerous studies have identified MRSA-positive colonies of *S. aureus*,[7,12,17,22] while others reported no MRSA growth on tourniquets.[13,23]

The health care workers (doctors, nurses, and laboratory phlebotomists) showed a lack of awareness; none of them identified tourniquets as a source of infection. Although, they were aware of nosocomial infections, they did not understand that they are spread through such objects. The personnel showed a lack of concern for hospital infection control practices, such as disinfecting tourniquets.

Surprisingly, nearly all (90%) the elastic tourniquets and only 41% of plastic or rubber tubing tourniquets had microbial colonization. Elastic tourniquets, which have in-folding that enhances their length and surface area, are easily colonized, while plastic and rubber tourniquets have a smaller surface area and a smaller diameter, halving the risk for colonization. Elastic tourniquets are reused more often than plastic and rubber models, as they are more costly and are therefore discarded infrequently, whereas plastic and rubber tourniquets are cheap, readily available, and cost-effective. Although many hospitals in Pakistan emphasize infection control practices, which include hand-washing and decontamination between procedures, it is difficult to control nosocomial infections, especially MRSA.[15] No data on the frequency, reusability, lifespan or types of tourniquets were available in Pakistan with which to compare our study. Nevertheless, hospital administrations should consider using effective disinfection of elastic tourniquets and should encourage the use of cost-effective plastic or rubber, disposable tourniquets or simple, latex-free tournistrips;[22,23] however, even instituting a policy for single-use

tourniquets would probably not be sufficient, as a health care worker with poor hand hygiene could transmit pathogens from a patient to a new tourniquet. Effective infection control practices like hand-washing before and after attending patients are simple and the best recognized means of preventing cross-contamination.[24] Discontinuing multiple-use tourniquets, using cost-effective, disposable tournistrips[25] and instituting active preventive methods like effective hand hygiene are the only effective means for preventing cross-contamination. Use of disposable tourniquets should be the rule, as there is no really effective way to disinfect reusable ones. Hospitals must be vigilant in anticipating the need for and implementing the improved methods necessary to provide a safe environment for patients.

CONCLUSIONS

This study demonstrates that tourniquets act as a source of pathogenic bacteria, including MRSA, and that health care workers lack awareness about tourniquets as a source of nosocomial infections. It also highlights deficiency in the knowledge of health care workers about infection control procedures and the effectiveness of hand hygiene.

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