Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/mjafi

Original Article

Bacterial colonization of peripheral intravenous cannulas in a tertiary care hospital: A cross sectional observational study

Col Amit Rai^a, Col Anurag Khara^{b,*}, Lt Mehul Jain^c,
Mathangi Krishnakumar^d, Brig D.K. Sreevastava^e

^a Senior Advisor (Anaesthesia & Paed Anaesthesia), INHS Asvini, Mumbai 400005, India

^b Commanding Officer, 421 Field Hospital, C/o 99 APO, India

^c Intern, Command Hospital (Eastern Command), Kolkata, India

^d Senior Resident (Neuro Anaesthesiology & Neurocriticalcare), NIMHANS, Bengaluru, India

^e Commandant, 174 Military Hospital, C/o 56 APO, India

ARTICLE INFO

Article history:

Received 1 October 2016

Accepted 24 April 2018

Available online 6 July 2018

Keywords:

Peripheral intravenous cannulas

Colonisation

Injection port

ABSTRACT

Background: The use of intravenous (IV) cannulas is an integral part of patient care in hospitals. These intravenous cannulas are a potential route for microorganisms to enter the blood stream resulting in a variety of local or systemic infections. Studies showing the actual prevalence of colonization of peripheral IV cannulas and its role in BSI are lacking. Hence, this study was aimed to estimate the prevalence of colonization of the injection ports of peripheral IV cannulas. **Methods:** This cross sectional study was conducted on patients admitted in ICU and wards in an 800 bedded tertiary care hospital. Swabs were taken from lumens of peripheral IV cannulas and cultured. Patient demographic data and practices followed for maintenance of IV line were noted.

Results: A total of 196 injection port samples were taken, out of which 11 tested positive for microbial growth (5.61%). *Staphylococcus aureus* was the predominant organism contributing 64% of the microbial growth. A significant association was seen between presence of local signs, old age and positive cultures. Flushing IV cannula every 6 h was associated with negative cultures. **Conclusion:** Peripheral IV cannulation has significant potential for microbial contamination and is largely ignored. Most of the risk factors associated with growth of microorganisms in the injection ports of peripheral intravenous cannulas (which has a potential to cause catheter-related blood stream infections) can be prevented by improving protocols for management. To prevent infection from occurring, practitioners should be educated and trained about the care and management of IV.

© 2018 Published by Elsevier B.V. on behalf of Director General, Armed Forces Medical Services.

* Corresponding author.

E-mail address: anuragkhara74@gmail.com (A. Khara).

<https://doi.org/10.1016/j.mjafi.2018.04.004>

0377-1237/© 2018 Published by Elsevier B.V. on behalf of Director General, Armed Forces Medical Services.

Introduction

The use of intravenous (IV) cannulas is an integral part of patient care in hospitals. These devices are used for the administration of fluids, nutrients, IV medications, blood products and for procuring blood specimens. Population studies have shown that more than 70% of inpatients need peripheral IV cannulas.^{1,2} In our 800-bedded hospital almost two and a half lakh peripheral IV cannulas are used per year. These IV cannulas are a potential route for microorganisms to enter the blood stream resulting in a variety of local or systemic infections. As compared to central venous catheters, the incidence of local or blood stream infections (BSI) associated with peripheral IV cannulas are usually low.^{1,2} However it can considerably prolong hospital stay, morbidity and mortality due to increased frequency of usage.

Microorganisms causing vascular catheter-related sepsis gain access to the bloodstream through either the skin at the catheter insertion site or through the catheter hub. There is enough evidence that the greatest risk for contamination of the IV catheters after insertion is the access hub with 30–50% being contaminated in normal patient use, whether adults or neonates.^{3–6} There is another school of thought that colonization of valved injection side ports of IV cannulas does not contribute significantly to BSI. Barring a couple of studies, which were done in peripheral IV cannulas, most of these studies focused on central venous catheters.^{7,9} Studies showing the actual prevalence of colonization of peripheral IV cannulas and its role in BSI are lacking.

The primary objective of the study was to estimate the prevalence of colonization of the injection ports of peripheral IV cannulas. We assumed that if the injection port is contaminated then certain microorganisms might migrate endo-luminally and cause blood stream infection. Our secondary objective was to analyze the prevalent practices in a tertiary care hospital and study their association with injection port colonization.

Materials and methods

This cross sectional study was conducted on patients admitted in ICU and acute surgical, medical and Obstetrics and Gynecology wards in an 800 bedded tertiary care center after obtaining ethical clearance from the institutional ethics committee. The participants were adult inpatients over 18 years of age, who needed peripheral IV therapy. Informed consent was taken from the participants prior to the study. Patients, who needed peripheral venous access for IV therapy, had a peripheral IV cannula in situ for more than 48 h but not more than 120 h were included in the study. As an institutional protocol, all health workers wash their hands with soap and water before wearing clean (but not sterile) gloves and then insert a peripheral IV cannula. We excluded participants who were comatose, had features of sepsis, HIV positive patients, patients with local signs of any skin lesion, patients with IV cannulas in lower extremity and patients who had the IV cannula for more than 120 h (based on CDC guidelines). The data was collected between May and August 2014 when the

number of participants proposed in the sampling calculation (196) was reached. The sample size was calculated based on a pilot study in 30 patients from the same wards, and the prevalence of injection port colonization was found to be in 13.4% of patients. To estimate the sample size for prevalence of 13.4% in the study population with a 5% absolute difference and 95% confidence levels, the sample size was worked out to be 179. To cater for any loss of samples during transit/reporting, an additional 10% sample was taken making it to 196 samples. All samples were collected by the same investigator who was trained for the same prior to the pilot study.

Systematic random sampling was done and we took samples from every fourth patient, based on a random number table, starting from the first patient who had an IV cannula for more than 48 h and was willing to be a part of the study. A total of 196 patients were taken for the study. The reading was taken on a daily basis and the sample was taken during the visit. At the time of sample collection, the site of insertion was inspected for the presence of redness, swelling and tenderness. Local inflammation was assumed to be present if two of the above criteria were present.⁷

Sterile water for injections, which is readily available in the wards, was used to wet the sterile swabs. The wet sterile swabs were then introduced into the lumen of the injection ports of the IV cannulas and then vigorously rotated (Fig. 1). The swabs were inoculated on two different culture media, i.e. Blood agar and MacConkey agar and then incubated at 37 °C. Agar plates were examined at 48 h. Significant growth was defined as more than 5 morphologically similar colonies.⁷

Fig. 1 – Sample being taken from the injection port.

The swabs which tested positive for microbial growth were then subjected to further tests like gram staining catalase test, oxidase test etc. for identification of the bacteria.

Data collected was entered into Excel. Statistical analysis was performed using SPSS version 21 for Windows (IBM Corporation, New York, USA). Chi-square and Fischers exact test was done for qualitative data. Bivariate analysis was done to identify selected risk factors for the outcome. $p < 0.05$ was taken as statistically significant.

Results

A total of 196 injection port samples were taken, out of which 11 tested positive for microbial growth 5.61% (3.16–9.77%). The median time for the inserted peripheral cannula was 55 h (range 48–108 h). The demographic profile of patients is given in Table 1. The median age of the population was 55 years. Older Age (>55 years) was associated with microbial growth ($p = 0.0140$). However, there was no significant association between sex and injection port contamination ($p > 0.05$). The prevalent practices variables associated with microbial growth are given in Table 2. *Staphylococcus aureus* was the predominant organism contributing 64% of the microbial growth (Fig. 2). There was a significant association between presence of local signs, inflammation and positive cultures (Table 2). Out of all the positive cultures, 63% were in cannulas which were inserted more than 55 h as compared to samples taken from cannulae which were less than 55 h in situ. However there was no significant association of the positive cultures with time since insertion ($p > 0.05$). Out of the 185 cannulae with negative cultures, 136 were flushed every 6 h, as compared

to 49 injection ports which were flushed just before giving any medication or starting IV fluids. Out of the 11 positive cultures, 8 injection ports were flushed 6 hourly while 3 were flushed just before injecting drugs. However, there was no statistically significant association with growth of microorganisms ($p > 0.05$).

Discussion

Out of the 196 injection port samples taken, 5.61% tested positive for microbial growth. Considering that approximately 250,000 peripheral IV cannulae are inserted every year in our hospital, it would translate into a huge number annually. Previous studies have shown the incidence of blood stream infections due to peripheral IV cannulas to be 0.1–0.2%.¹ There is no literature which gives prevalence of microbial growth at injection ports only.

In our study, *S. aureus* was grown in 63.6% of the samples that showed positive growth. The most common microorganisms associated with infections associated with IV cannulae are those that occur naturally on the skin (skin commensals),

Fig. 2 – Distribution of organisms isolated from positive cultures.

Table 1 – Demographic variables among participants with and without microbial growth in the injection ports of peripheral IV catheters.

Variables	Microbial growth present (n = 11)	Microbial growth absent (n = 185)	p value
Ward			
Surgical	05	55	0.114
Medical	06	130	
Sex			
Male	06	115	0.360
Female	05	70	
Age			
<55 years	02	89	0.0140
>55 years	09	96	

Table 2 – Various variables associated with microbial growth in the injection ports of peripheral IV catheters.

Variables	Microbial growth present (n = 11)	Microbial growth absent (n = 185)	p value
Local signs			
Present	07	20	0.023*
Absent	04	165	
Time since insertion			
<55 h	04	95	0.539
>55 h	07	90	
How often flushed			
6 hourly	08	136	0.482*
Before injecting drugs	03	49	

* Fisher's exact test used in view of at least one cell (25%) having expected count less than 5.

particularly staphylococci, which originate from the skin of both healthcare professionals and patients. Other common organisms that are associated are commensals of bowel flora, which may get transmitted by hands, equipment or IV fluids (*Enterococcus*, *Klebsiella*, *Pseudomonas*, *Serratia*, *Enterobacter*).⁸ The dominance of staphylococci may be explained by the opportunity for colonization from skin when in contact with peripheral IV cannulas.

In our study population, 13.8% of cannulas with positive cultures were associated with local inflammation and there was a significant association between presence of local signs and positive cultures. This is in contrast with another study where the authors found that one fourth of the cannulas are associated with local inflammation, but majority (78%) of the cannulae with local inflammation were culture negative.⁹ The reasons for this wide variation include differences in the populations and type of cannulas studied, as well as differences in definition of significant local inflammation. We found that there was a significant association between positive cultures in patients more than 55 years of age. Since the distribution of the data was not normal, hence median split was done and we arrived at the cut off of 55 years. Increasing age has been associated with increased incidence of phlebitis in earlier studies also.¹⁰ Similarly, peripheral venous cannulas placed in women have been shown to develop a larger proportion of complications as compared to men.⁹ We did not find any association of sex with the positive cultures.

In our study there was no significant association between microbial growth and time since insertion. This was a significant finding since it is a popular belief that PICs should be replaced every 72–96 h to prevent phlebitis and catheter-related infections. Centers for Disease Control also recommend this in their guidelines for prevention of intravascular catheter related infections.¹¹ However, a cochrane review found that there is no benefit in changing cannulas every 72–96 h and recommended that cannulas should be changed only if clinically indicated.¹² Similar recommendations were also found in a randomized controlled equivalence trial,¹³ and in the recently published guidelines for safe vascular access, by the Association of Anaesthetists of Great Britain and Ireland.¹⁴

There are two trends prevalent in our hospital regarding flushing of IV cannulas. Most wards follow the practice of flushing injection ports with normal saline every 6 h and some flush the injection ports just prior to injecting drugs/connecting IV sets. We found that out of all the IV cannulas, which did not show any growth, 73% were flushed every 6 h. Based on the current evidence and our findings it would be good practice to flush the IV cannulas every 6 h with normal saline when used for intermittent administration of drugs fluids.

One of the limitations of the study was that the sample collection was done from every fourth patient based on a systematic random sampling technique. However, since we did not note the type of drugs being administered nor did we collect information about the size of cannulas or site of insertion, it could have resulted in a bias.

From our study, we observed that 5.61% of patients with peripheral IV cannula have microbiological growth in the injection ports, which has a potential to cause significant

morbidity and mortality. Peripheral IV cannulation has significant potential for microbial contamination and is largely ignored. Since we did not do blood cultures as a part of our study it would be difficult to comment how many of these would actually end up causing blood stream infections. Besides this there were observations regarding practices (though insignificant), which may have an association with the growth of microorganisms.

We calculated the post test power for the secondary objectives. The power to find the association if it existed between presence or absence of microbial growth was 97%, 8% and 4% for local signs, time since insertion and how often flushed respectively. Further studies with an appropriate sample size may be undertaken to identify the patient or provider related factors for peripheral IV cannula infections.

Standard guidelines for care of peripheral IV cannulas exist and if followed diligently, may reduce the incidence of microbial growth. Routine changes of peripheral IV cannulas at 72–96 h should be avoided. However, prevention of PIC infection is only sustainable if there is a commitment from all levels of the organization – infection prevention is everyone's business.

Conflicts of interest

The authors have none to declare.

REFERENCES

1. Maki DG, Kluger DM, Crnich CJ. The risk of bloodstream infection in adults with different intravascular devices: a systematic review of 200 published prospective studies. *Mayo Clin Proc.* 2006;81(9):1159–1171.
2. Ena J, Cercenado E, Martinez D, Bouza E. Cross-sectional epidemiology of phlebitis and catheter-related infections. *Infect Control Hosp Epidemiol.* 1992;13:15–20.
3. Salzman MB, Rubin LG. Relevance of the catheter hub as a portal for microorganisms causing catheter-related bloodstream infections. *Nutrition.* 1997;13(suppl):15s–17s.
4. Sitges-Serra. Strategies for prevention of catheter-related bloodstream infections. *Support Care Cancer.* 1999;7(6):391–395.
5. Salzman MB, Isenberg HD, Shapiro JF, Lipsitz PJ, Rubin LG. A prospective study of the catheter hub as the portal of entry for microorganisms causing catheter-related sepsis in neonates. *J Infect Dis.* 1993;167:487–490.
6. Mermel LA. What is the predominant source of intravascular catheter infections? *Clin Infect Dis.* 2011;52(2):211–212.
7. Cheesbrough JS, Finch RG. Studies on the microbiological safety of the valved side-port of the 'Venflon' cannula. *J Hosp Infect.* 1985;6(2):201–208.
8. Wilson J. Preventing infection associated with intravascular therapy. In: *Infection Control in Clinical Practice.* 3rd ed. London: BaillièreTindall; 2006:199–213.
9. Cheesbrough JS, Finch RG, Macfarlane JT. The complications of intravenous cannulae incorporating a valved injection side port. *J Hyg.* 1984;93:497–504.
10. Ascoli GB, Deguzman PB, Rowlands A. Peripheral intravenous catheter complication rates between those indwelling >96 hours to those indwelling 72–96 hours: a retrospective correlational study. *Int J Nurs.* 2012;1(2):7–12.

11. O'Grady NP, Alexander M, Burns LA, et al. *CDC Guidelines for the Prevention of Intravascular Catheter-related Infections*. 2011.
12. Webster J, Osborne S, Rickard C, Hall J. Clinically indicated replacement versus routine replacement of peripheral venous catheters. *Cochrane Database Syst Rev*. (March (3)):2010;(March (3)):CD007798.
13. Rickard CM, Webster J, Wallis MC, et al. Routine versus clinically indicated replacement of peripheral intravenous catheters: a randomised controlled equivalence trial. *Lancet*. 2012;380(22):1066–1074.
14. Bodenham A, Babu S, Bennett J, et al. Association of Anaesthetists of Great Britain and Ireland Guidelines for safe vascular access 2016. *Anaesthesia*. 2016;71:573–585.