Correlation of Intra Vascular Cannula Insertion Technique and Ward Practices with Local Site Infection

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Abstract

Background: Peripheral intravascular cannulas are indispensable in modern day medical care. These cannulas, if not inserted properly, predispose a patient to various morbidities. The present study was carried out to assess the incidence of intravascular cannula associated infections and correlate it with cannula insertion techniques and ward practices.

Methods: The study was carried out in the wards of a tertiary care hospital. The study was divided into two phases, each phase comprising of 50 patients. In phase 1, cannula insertion was carried out after normal ward cleaning practices. In phase 2, cleaning of the site was done by standard surgical cleaning procedure. The cannula samples after removal were cultured and local signs of thrombophlebitis looked for at the site of insertion. Thrombophlebitis was considered a surrogate marker of local infection in the vessel wall.

Result: The relative risk of acquiring thrombophlebitis increased by 2.18 times (applying univariate analysis) by existing methods as compared to the standard method.

Conclusion: Use of standard cleaning protocol had a significant effect on decreasing the incidence of cannula associated infections and cannula related morbidity.

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Key Words : Intravascular cannula; Peripheral vein thrombophlebitis; Cannula associated infections

Introduction

Peripheral intravascular cannulas are indispensable in modern medical practice [1]. There are also a growing number of patients on “home” intravenous (IV) therapy, predominantly for total parenteral nutrition (TPN). Although such peripheral venous cannulas provide necessary vascular access, their use puts patients at risk for local and systemic infectious complications, including local site infection, infusion extravasations, cannula related blood stream infections, septic thrombophlebitis etc causing significant morbidity.

Though the incidence of local or blood stream infections (BSIs) associated with peripheral venous cannulas is usually low, serious infectious complications produce considerable annual morbidity because of the frequency with which such cannulas are used [2].

With increasing numbers of immunocompromised patients attending hospitals, the risk of cannula associated infections is bound to rise. Strategies for reducing risk include maximal barrier precautions during cannula insertion and continuous quality improvement programs [3].

Material and Methods

The study was carried out in the wards of a tertiary care hospital over a period of five months. One hundred patients in whom IV cannula was being inserted were recruited from the medical and surgical wards of the hospital. Only those patients in whom IV cannula insertion was observed were included in the study. They were followed up till cannula removal, which was done by the researcher himself. Immunocompromised patients, those patients in whom the cannulas were indicated for less than 24 hours, patients on any chemotherapy for malignancy and those diagnosed as sepsis syndrome were excluded from the study.

The study was divided into two phases. In phase I, prevalent cannula insertion procedure in 50 consecutive patients was observed (which was cleaning the site only with spirit and inserting the cannula with non sterile gloves on in all the cases). In phase II, a standard cannula insertion protocol was followed for 50 consecutive patients which consisted of the following steps :

1. Identify insertion site
2. Tie a tourniquet above the site of insertion
3. Clean with savlon
4. Paint with povidone iodine and allow it to dry

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5. Swipe the painted area with spirit
6. Insert cannula with sterile gloves on
7. Clean site of spilt blood
8. Apply soframycin cream at the site of puncture
9. Apply micropore/elastoplast (to securely anchor the cannula)

Points noted during insertion of the cannula were patient's particulars, diagnosis, person inserting the cannula (who were classified as skilled and semi skilled), the number of attempts taken at insertion, site of insertion, guage of cannula used and the type of procedure followed during insertion.

In phase II of the study all efforts were made to match the baseline characteristics of the patients with those recruited in phase I. This was done by selecting almost the same number of patients from each ward as in phase I. Sex of the patients was the same, i.e. males, as the service hospitals cater primarily to serving personnel who are males. The mean age of patients in phase I was 46.6 years compared to that of phase II which was 46.4 years. Almost all of them were receiving the same antibiotics, the most common indication being post surgical antibiotic prophylaxis (85%) and other medical illnesses (15%). Duration of antibiotic use in all the patients was 4 to 5 days. None of the patients received parenteral nutrition or any anticoagulants. Limitation of the study was the sample size.

After cannula insertion, time and date of the same was written on the adhesive plaster with indelible ink. The enrolled subjects were followed up till cannula removal. All the patients in both the phases received the same antibiotics which included aminoglycosides, cephalosporins and penicillin.

During withdrawal, the duration for which the cannula remained in situ was noted along with the condition of the patient and presence of any signs of thrombophlebitis like redness, swelling, tenderness, increased temperature at the site, palpable/tender veins and a positive culture report.

To increase the specificity, presence of any two or more positive signs was taken as evidence of thrombophlebitis. Occurrence of fever or any sign other than mentioned above was also recorded.

The external surface of cannula, after removing, was smeared on blood agar plates and two drops of blood from cannula was also plated. After this the cannula tip was cut by a sterile surgical blade and put in brain heart infusion (BHI) for culture [4]. Strict aseptic precautions were observed during the entire procedure. Culture reports were collected after 48 hours. In case of positive culture, antibiotic sensitivity tests were done on a subculture.

Statistical test used were t test, chi squares and software used for data analysis were the "Standard R-2.7.2" and Microsoft Excel 2003.

Results

Out of 50, 24 (48%) patients in phase I and 11 (22%) patients in phase II turned out positive for thrombophlebitis (Fig.1). In phase I, proportion of positive outcome is 48% with 95%

confidence interval (CI_{95}) as 33.66 to 62.58. In phase II proportion of positive outcome is 22% with CI_{95} as 11.52 to 35.96. On applying univariate analysis and analyzing the data it was found that relative risk is 2.18 with CI_{95} as 1.20 to 3.96. This implies that the relative risk of acquiring thrombophlebitis increases by 2.18 times by normal method compared to the standard method. In phase I, five (10%) out of 50 and in phase II, only one (2%) out of 50 cannula plating were found to be culture positive for *Staphylococcus aureus*. The difference in outcome of other parameters that were observed is shown in Fig. 2.

Other parameters considered for univariate analysis were duration, needle guage, attempts at insertion, sites of insertion and expertise of persons performing cannula insertion practice.

Cannulas of 16, 18, 20, 22 and 24 guages were used during the study. However for univariate analysis the size was grouped as 16 to 18 <1> and 20 to 24 <2>. There was no significant difference ($p=0.77$) i.e. occurrence of thrombophlebitis is independent of guage of cannula used. Fig. 3 shows the total number of various guage of cannulas inserted and those which resulted in thrombophlebitis.

Expertise of persons performing cannula insertion was also taken into account. Insertion was carried out by trained nurses, probationer nurses and undergraduates. Inserters were divided into two groups as skilled (trained nurses) and semiskilled (probationer nurses and undergraduates). There

Fig. 1 : Comparison of thrombophlebitis in phase I and II.

Fig. 2 : Comparison of incidence of positive culture (C) and occurrence of redness (R), swelling (S), tenderness (Tn), raised temperature (Tm) and distended vein (D) in the two phases.

Fig. 3 : Total number of various gauge size cannulas inserted and those which resulted in thrombophlebitis.

Fig. 4 : Comparison of occurrence of thrombophlebitis between skilled (trained nurses) and semi skilled (probationer nurses and undergraduates).

was no association between the insertion skill and the occurrence of thrombophlebitis. Fig. 4 compares positive and negative incidences between the two groups.

The effect of number of attempts taken to insert the cannula was also considered. The effect was found insignificant. Fig. 5 depicts the number of insertions at 1st and 2nd attempts and their outcome.

The catheter was inserted at the following three sites :

Site 1-Hand Site 2-Wrist joint Site 3-Forearm

From Fig. 6 it is seen that insertion at wrist joint in phase I leads to higher incidence of thrombophlebitis as compared to other sites. We are unable to fully explain this, but it may be due to the fact that the cannula tips placed at sites of greater mobility like joints are more likely to damage the endothelium. However, incidence of thrombophlebitis with regard to other two sites of insertion was not different in the two phases studied.

The incidence of thrombophlebitis was correlated to the duration for which the cannula remained in situ and the same is shown in Fig.7. The highest incidence of developing thrombophlebitis is within a few hours of insertion (the 3 patients in 0-24 hour group are those patients who required cannulas for more than 24 hours but developed thrombophlebitis soon after insertion). This probably is a reflection of poor insertion technique traumatizing the vessel wall or infection associated with less than optimal aseptic precautions.

Fig. 5 : Showing the number of insertions at 1st and 2nd attempts and their outcomes.

Fig. 6 : Comparison of total insertions at a site (S1 – Hand, S2 – Wrist joint, S3 – Forearm) to positive outcomes at those sites in phase I (P1) and phase II (P2).

Fig. 7 : Shows the time duration of insertion of cannula and development of thrombophlebitis.

Discussion

Approximately 90% of all patients entering the hospital environment for care have some form of IV therapy during their hospital stay. A safe and stable vascular access by IV cannula is essential to the practice of modern medicine. However, the insertion and daily use of these devices is associated with risks and complications that can significantly impact the clinical status and outcome of the patient. Blood stream infection involving these catheters is a major cause of morbidity and mortality all over [5].

Cannula related infections account for approximately 30% of all hospital acquired infections

and can be reduced by scrupulous adherence to cannula insertion techniques and subsequent care. Most IV cannula infections result from either cannula contamination infection by pathogens occurring during cannula placement (extra luminal) or during manipulation of hubs or cannula junctions during use (intra luminal) [6].

The primary source of most pathogens causing endemic cannula associated BSI are the cannula insertion site or the cannula hub. Colonization occurs when microorganisms are present and multiplying but are not invading the tissue or causing damage. Staphylococci and enterococci account for most cannula related BSI, with more than half being caused by gram positive staphylococci [2]. These organisms migrate along the outside or inside lumen of the IV cannula and form a biofilm causing colonization. If this biofilm breaks, it leads to systemic sepsis and even emboli formation which is seen more in patients of heart diseases.

Non adherence to standard aseptic precautions led to the increase in the incidence of thrombophlebitis by 2.18 times in our study which has also been proved by other studies [5,7]. Repeated attempts by health care worker at the site of cannula insertion or venipuncture should generally be avoided as it causes unnecessary trauma to the patient and limits future vascular access [8]. In our study, though the incidence of thrombophlebitis at second attempt increased, it was not significant.

IV cannula and skin junction sites should be assessed for potential complications (redness, tenderness, pus, warmth and edema) at established intervals so as to detect thrombophlebitis and treat it at the earliest, thus reducing morbidity. Venous cannula sites should be kept scrupulously clean. Any blood staining of the plaster or dressing is an indicator for changing the dressing after cleaning the site with 70% ethanol or povidone iodine.

The relative risk of acquiring thrombophlebitis

decreases by 2.18 times by using the standard method of cannula insertion. It is thus amply demonstrated that meticulous adherence to insertion procedure plays an important role in decreasing IV cannula associated morbidity. Other parameters like needle gauge, sites of insertion, duration of insertion, number of attempts at insertion and expertise of persons have little bearing.

Conflicts of Interest

None identified

Intellectual Contribution of Authors

Study Concept : Capt A Gupta, Gp Capt VK Sashindran

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