Reducing infiltration rates of peripheral intravenous cannula: A quality improvement initiative in a neonatal intensive care unit of tertiary care hospital in Northern India

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ABSTRACT

Background: Peripheral venous access is used for infusion of fluids, medications, and blood products. Penetration of these products through an intravenous (IV) access to surrounding tissues causes infiltration or extravasations injuries. **Objective:** The objective of the study was to measure the incidence of peripheral IV cannula (PIV) infiltration in neonates and reduce infiltration rate by at least 30 % from baseline rate. **Methods:** This was a quality improvement (QI) study, conducted in the neonatal intensive care unit from March 2018 to June 2018. All the neonates with PIV cannula irrespective of gestational age, postnatal age, and weight were included in the study. The baseline rate of PIV infiltration was determined. A team of doctors and nurses performed root cause analysis of factors responsible for PIV cannula infiltration using fishbone analysis. Various change ideas were tested through sequential Plan-Do-Study-Act cycles. **Results:** Infiltration rate of PIV cannula after intervention decreased from a baseline incidence rate of 60.8/100 IV–21.4/100 IV days over the study period. **Conclusions:** A QI approach was able to accomplish a reduction in the infiltration rates of PIV cannula in our unit.

Key words: *Infiltration, Peripheral intravenous cannula, Quality improvement*

Peripheral venous access is used for infusion of fluids, medications, and blood products. Penetration of these products through an intravenous (IV) access to surrounding tissues causes infiltration or extravasations injuries and accounts for 23–78% of complications of peripheral IV (PIV) access [1]. Terms extravasations and infiltration are often used interchangeably; though extravasations occur as a result of endothelial damage due to the administration of vesicant medication while infiltration occurs with non-vesicant medication [2]. Typically, infiltration severity can range from Stage 1, where no swelling is present, to Stage 4 infiltrates that results in marked swelling, impaired circulation, skin breakdown, or necrosis [3]. Neonates are prone to infiltration due to their fragile vessels and a comparatively lesser amount of subcutaneous tissue [4]. Complications progress quickly from reduced tissue perfusion to tissue necrosis and even results in limb loss [3-8].

A survey of regional neonatal intensive care units (NICU) reported infiltration rate of 38/1000 babies which led to skin necrosis; most were due to PIVs [7]. The authors from Turkey reported the incidence of infiltration/extravasations in 45.6% of PIVs inserted into newborns; 9.7% were Stage I and 11.7% were Stage IV [9]. A study from India reports 86.6% cannulas (161 out of 186 cannulas) were infiltrated in 78 neonates [10]. Despite the

potential for serious morbidity in the neonatal population, there are very few reports on the burden of PIV infiltration. Further, literature regarding interventions for reduction of infiltrates is meager [11-15]. Based on frequent observations of several cases of PIV infiltration, we conducted this study to find out the incidence rate of PIV infiltration in our NICU and reduce the rate through quality improvement (QI) methods.

METHODS

This was a QI initiative conducted in NICU of a tertiary care teaching hospital in Northern India, from March 2018 to June 2018. The unit comprises 10 level III NICU beds, 10 step-down beds, and 10 beds for babies in the maternity ward. All the admitted babies in NICU, who required PIV cannula, were included for collection of data after getting consent from the respective parents. Neonates with central lines or peripherally inserted central catheter (PICC) were excluded. Babies shifted to step down unit were also excluded as the chances of them having IV cannulas were low. The Institute Ethics Committee approved the study with a waiver of consent. The study was conducted in two phases, i.e., baseline phase of 4 weeks and the implementation phase over 12 weeks.

In the baseline phase, data on the rate of PIV infiltrates were collected over a period of 4 weeks. This was done by voluntary reporting by nurses and doctors; counting a total number of inserted cannulas each day by proxy, with the help of cannula boxes, especially made for the collection of cannula covers of inserted cannulae; and nursing report book. The study objective was to decrease the baseline rate by at least 30% over the next 12 weeks.

A team comprising one faculty doctor, one resident doctor and two nurses was formed. The team tried to find out possible reasons for PIV cannula infiltration in our unit using fishbone analysis (Fig. 1). The major barriers were: inadequate knowledge of insertion procedure and identification of early stages of infiltration; absence of a unit policy on steps; maintenance of PIV cannula; and overlooking of catheter sites by nurses due to busy shifts.

During the implementation phase, these factors were addressed using a series of Plan-Do-Study-Act (PDSA) cycles (Table 1). The nurses and resident doctors were educated in early identification, and preventive measures of PIV infiltrates, particularly early stage injuries, using PowerPoint presentations, visual aids, and bedside skill teaching. Handouts and posters of infiltration grading charts were provided. These include – avoidance of joint for insertion site; 2- hourly IV site inspection; checking patency before infusion; use of transparent dressing for fixation; use of small volume saline flush after each medication; and use of extension line followed by looping it and documenting the IV infiltration event. A comprehensive unit policy on PIV cannula insertion procedure and maintenance was made.

During clinical rounds each day, nurses were appreciated for their efforts on a one-to-one basis. Closed group social media platform was used for positive reinforcement and for reminders and messages for improving clinical practice. A combined meeting of all team members was conducted every fortnightly, to analyze the results and provide feedback to all the staffs. The primary outcome measure was the rate of PIV infiltration. This was calculated using the formula: Total no of reported infiltration $\times 100$/no of PIV days. The PIV days were calculated as a number of indwelling PIV cannulas each day for that month.

Descriptive statistics were used to describe baseline characteristics of the patient population. Data were analyzed using Microsoft Excel version 2011. Attribute u-charts were used to display and interpret the serial measurement of indicators and to study the impact of changes. This type of chart accounts for differing sample sizes over time in this study the number of line days per month [16]. Significant changes; were interpreted as per standard rules.

RESULTS

Demographic characteristics of the study population in the baseline and implementation phase were comparable (Table 2). The baseline incidence of infiltration was 60.8/100 IV line days.
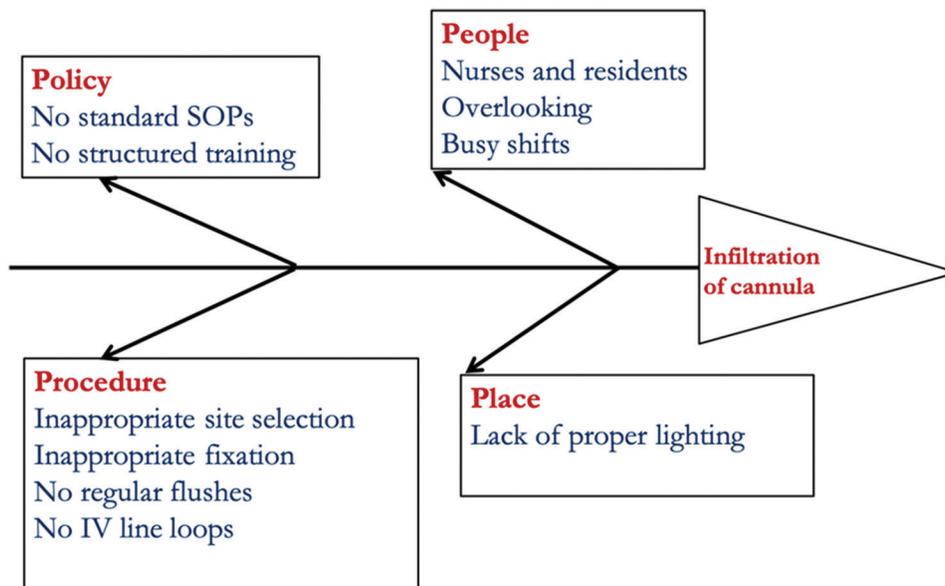

Figure 1: Fishbone analysis

Table 1: PDSA cycles

No.	Plan	Do	Study	Act
1	Education of nurses and resident doctors about infiltration injury	Use of PowerPoint presentations, visual aids, bedside skill teaching	Infiltration rate decreased slightly (58.2/100 IV line days)	Infiltration record and grade charts put bedside to be filled in every shift
2	Unit policy on insertion technique and maintenance	Education and skill demonstration	Infiltration rate decreased (33/100 IV line days)	Unit policy compliance check
3	Attitudinal change	Appreciation, reminders, positive reinforcement	Infiltration rates decreased (21.4/100 IV line days)	Ongoing sensitization and positive reinforcement

PDSA: Plan-Do-Study-Act

Following the implementation of interventions, there was a gradual decline in the infiltration rate from 60.8 to 21.4/100 IV line days (Fig. 2). This special cause event was related to rigorous implementation and performance monitoring of interventions in the PDSA cycles. The average duration of cannula before infiltration was 18.2 h during the baseline phase, which increased to 42.2 h by the end of 3 months (Table 3).

DISCUSSION

This QI effort was a stepwise introduction of measures to reduce PIV infiltration rate in our unit driven by PDSA cycles. There was a reduction in overall PIV infiltration rates by 64.8% from baseline at the end of the third PDSA cycle. Furthermore, there was an improvement in the average duration of cannula before infiltration.

The barriers, associated with PIV infiltration, found in the study were similar to other studies. Several studies have observed gaps in practices such as lack of knowledge about infiltration injury, inability to recognize the injury, lack of perceived priority to assess IV site for infiltration, and attitudinal problems such as resistance in accepting new practices [10,17-19]. Technical factors associated with infiltration include over-reliance on infusion pump alarms, infrequent checking of sites, type of medicines, and use of inappropriate dilutions. A study from India observed cefotaxime infusion as an important aggravating factor for infiltration [10]. A QI audit of nursing practices for PIV therapy found 52.2% of PIVs were infiltrated despite having NICU guidelines for insertion. Lower-extremity placements were associated with more frequent leakage and scalp placements with more occlusion [19].

Role of educational interventions in decreasing PIV infiltration cannot be overemphasized. Use of workshops, informative PowerPoint presentations, posters, laminated cards, online modules for assessment, and skill demonstration have reportedly decreased PIV infiltration in various studies [14,20-22]. Timely site assessment, restricting a number of attempts, early central access and formulation of unit policy or algorithm for PIV insertion and prevention have observed a reduction in infiltration injury [14,20-21,23]. In addition, the involvement of the family in identifying the infiltration injury has also been successful in one study [22]. Along with these interventions, we used a closed group social media platform for appreciation, reminders, and positive encouragement of NICU staff.

This study demonstrated a gradual decline in infiltration rates and improved duration of the cannula with unsophisticated existing measures. There was initial resistance to change in practice in our unit. Nevertheless, with consistent efforts along with positive reinforcement of staff, there was a decrease in PIV infiltration rate. There were a few limitations to this study; first, being a single-center study, the interventions implemented by us may not be a generalized factor (such as lack of resources or willingness to improvise the process) to other settings. Second, we have not studied the sustainability of the improvements achieved in the study unit over a long period. However, we will continue to monitor the compliance with this QI initiative to sustain the results.

Table 2: Baseline characteristics of the population

Variable	Pre-implementation phase	Implementation phase
Total number of babies	29	77
Gestation age in weeks[a]	35.5 (33–38)	36 (32–37)
Birth weight in grams[a]	1708 (2328–3075)	2200 (1300–2500)
Male gender n (%)	24 (82.7)	61 (79.2)

[a]Values are expressed in median (interquartile range)

Table 3: Monthwise record of infiltration injury

Variable	1st month	2nd month	3rd month	4th month
Average number of IV cannula inserted per day	4.8	3.9	2.9	1.9
Average infiltration rate[a] (per 100 IV line days)	60.8 (21.5)	58.2 (25.2)	33 (24.9)	21.4 (17.0)
Duration of cannula (hours)[a]	18.2 (10.1)	42.9 (23.1)	41.3 (21.9)	42.2 (24.2)

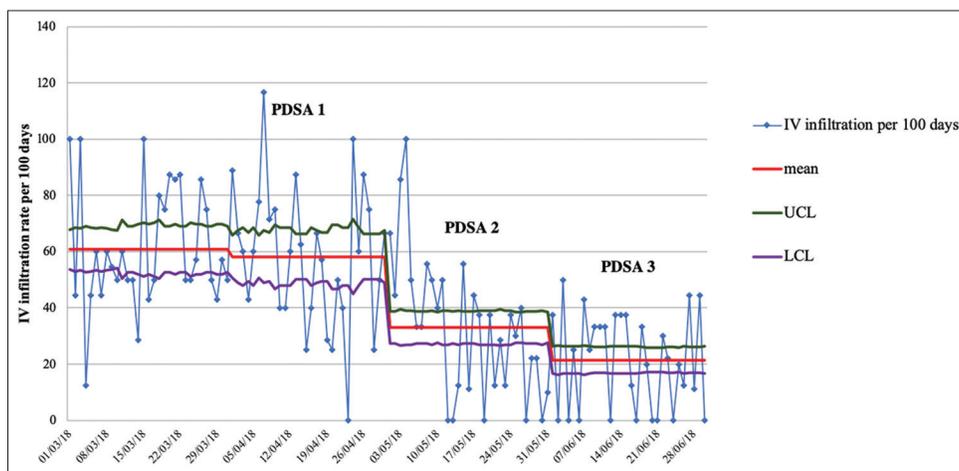[a]Values are expressed in mean (SD). SD: Standard deviation

Figure 2: U-chart

CONCLUSIONS

This QI study demonstrated that with available resources and simple measures, it is possible to improve the PIV infiltration rate. To sustain the improvement, we continue to use visual reminders, regular education, compliant to unit policy, and positive reinforcement.

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