Original Article

DOI: 10.7860/JCDR/2017/23600.9570

Anaesthesia Section

A Study of Morbidity and Cost of Peripheral Venous Cannulation in Neonates Admitted to Paediatric Surgical Intensive Care Unit

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ABSTRACT

Introduction: Peripheral venous access in sick neonates is indicated for administration of fluids, drugs or nutrients.

Aim: We conducted an audit of peripheral venous access in neonates admitted to paediatric surgical intensive care unit to study the morbidity, time spent on cannulation and cost with its use.

Materials and Methods: One hundred consecutive neonates requiring hospital admission to paediatric surgical intensive care unit in a period of one year were included in the study. Peripheral venous access was secured in all patients. We conducted an audit for the number of venipuncture sites, wastage of cannulae, cost, time spent on cannulation and morbidity with its use. Neonates were divided into three groups depending on their surgical intervention. Namely, Group A (thoracic procedures), Group B (bowel surgery) and Group C (other surgery and non-operative cases).

Results: In Group A, mean venepuncture sites were 10.66, used cannulae were 5.6, wasted cannulae were 4.3, total cost of cannulation was 870 rupees and 93.78 minutes were spent in cannulation per neonate. In Group B, mean venepuncture sites were 7.58, used cannulae were 4.35, wasted cannulae were 2.59, total cost of cannulation was 603 rupees and 59.85 minutes were spent in cannulation per neonate. In Group C mean venepuncture sites were 2.78, used cannulae were 2.9, wasted cannulae were 0.57, total cost of cannulation was 232 rupees and 26.51 minutes were spent in cannulation per neonate. Thrombophlebitis severity was greater in neonates who had longer ICU stay and ventilator dependent days.

Conclusion: Peripheral venous cannulation of longer duration is costly, time consuming, and associated with significant neonatal morbidity. It may be worthwhile to consider alternative vascular devices such as peripherally inserted central catheters or central venous catheters in such situations.

Keywords: Neonatal cannulation, Paediatric intensive care unit, Thrombophlebitis, Venous access

INTRODUCTION

The clinical needs and challenges of infusion therapy in neonates require approaches, tools and problem solving techniques that ensure that potential risks to this vulnerable population are significantly reduced [1,2].

Neonatal veins are small and fragile. Fragile vein pose difficulty in cannulation and have low tolerance to changes in pH as well as osmolarity. Hence, incidence of thrombophlebitis and requirement of multiple venous accesses is high in newborns receiving hypertonic solutions [3]. The more the length of ICU stay and ventilator dependant days; the more severe is thrombophlebitis [4].

The study was conducted with the:

Primary Aim

1. To study the morbidity, time spent on cannulation and cost with peripheral venous cannulation in neonates admitted to paediatric surgery intensive care unit.

Secondary Aim

1. To compare length of ICU stay and incidence as well as severity of thrombophlebitis.

MATERIALS AND METHODS

This observational study was conducted after approval from Hospital Ethics Committee and parental permission. All consecutive neonates admitted to the paediatric surgery ICU, and who fulfilled the inclusion criteria (100 amongst 114 neonates), from September 2011 to August 2012, were enrolled in the study. Neonates requiring IV access during hospital stay, and those undergoing a surgical procedure were included in the study. Babies with preterm birth, low birth weight, sepsis at the time of admission and those with complex congenital heart disease were excluded (14 amongst 114 neonates). Neonates not requiring IV access during their hospital stay (ward and ICU) were also excluded.

Depending upon the type of surgical intervention, neonates were devided into three groups: A,B and C. Group A comprised of neonates having thoracic surgeries, Group B with abdominal surgeries and Group C with other surgeries and non-operative cases. A 24 G peripheral venous cannulae was used for cannulation in all patients. Peripheral venous access site would be changed if the patient developed more than Grade II thrombophlebitis, extravasation or if the cannula got blocked, whichever was earlier. In all patients enrolled for the study, the observations were continued throughout their stay in paediatric surgery ICU and further during their course in the paediatric surgical ward after paediatric surgery ICU discharge.

The following variables (observed and calculated) were recorded in each group.

1) Number of venepuncture sites

2) Number of peripheral cannulae opened per patient

3) Number of peripheral cannulae used per patient

4) Number of peripheral cannulae wasted per patient

5) Total cost of intravenous (IV) cannulation per patient.

6) Time spent on venous cannulation

7) Incidence and severity of thrombophlebitis

Cost of cannulation included only the actual cost of the cannulae. No additional charges were included. Wasted intravenous cannula was defined as the total number of peripheral venous cannula which was opened to achieve venous cannulation subtracted by intravenous cannula actually inserted in neonates.

Thrombophlebitis was graded as following [5]

Grade I- Pain without other inflammatory signs

Grade II- Pain with erythema or swelling

Grade III- Pain, erythema, oedema and a palpable venous cord extending less than 5 cm

Grade IV- All signs of Grade III in an extension of more than 5 cm with peri-vein induration

Grade V- Frank vein thrombosis with or without suppuration and or ulceration.

STATISTICAL ANALYSIS

Analysis of the difference between the three groups was performed using the chi-squared test and Kruskal Wallis test. A p-value of < 0.05 was considered statistically significant.

RESULTS

A total of 100 neonates (43 female and 57 male neonates) admitted to paediatric surgery ICU were enrolled in the study. About 14 neonates did not meet the inclusion criteria, hence were excluded. The sample population included 34 neonates undergoing thoracic surgery like tracheoesophageal fistula repair, congenital diaphragmatic hernia repair etc., 33 who underwent abdominal surgery for bowel atresia, intestinal obstruction, intestinal malrotation etc., and 33 who underwent other procedures like abscess drainage, posterior urethral valve fulguration, meningomyelocoele repair, ventriculoperitoneal shunt, cystoscopy etc. Age of the neonates ranged between 1 to 27 days and weight between 2.1 and 3.2 kg. Mean age of neonates in Groups A, B and C was 2.75, 5.91 and 8.15 days respectively. Mean weight of neonates in Groups A, B and C was 2.23, 2.19 and 2.58 kg respectively. Mean duration of ICU stay was 8.96, 7.82 and 1.42 days per neonate in Groups A, B and C respectively [Table/Fig-1].

Ventilator dependent days averaged 5.12, 1.23 and 0.03 days per neonate in Groups A, B and C respectively. Statistical analysis revealed significant p-value (<0.001) for above observation.

All patients in Groups A and B and only 11 neonates in Group C developed thrombophlebitis, necessitating cannula change at some point during their treatment.

More severe grades of thrombophlebitis were found in Group A followed by Group B. No patient in Group C developed thrombophlebitis more than Grade II. Statistical analysis revealed significant p-value (<0.001) for this observation [Table/Fig-2]. All neonates received 10% dextrose in isolyte P, calcium gluconate, antibiotics; some were also on inotropes during their ICU stay. Median value of venepuncture sites per neonate was 9 in Group A, 6 in Group B and 2 in Group C with interquartile range of 7, 9 and 3 in Groups A, B and C respectively.

Median of peripheral cannulae opened per neonate was 7 in Group A, 5 in Group B and 2 in Group C with interquartile range of 7, 8 and 2 in Groups A, B and C respectively.

Median of peripheral cannulae used per neonate was 4 in Group A, 3 in Group B and 2 in Group C with interquartile range of 3, 4 and 2 in Group A, B and C respectively. Median of peripheral cannulae wasted per neonate was 3 in Group A, 2 in Group B and 0 in Group C [Table/Fig-3].

The average cost of a 24 G peripheral access cannula available in our hospital was rupees 87. Only the cost of cannula to patients, total cost of IV cannula per neonate during hospital stay was 870, 603.88 and 232 rupees in Groups A, B and C respectively. Mean time spent in IV cannulation perneonate was 93.78, 59.85 and 26.51 minutes in Groups A, B and C respectively. Statistical analysis revealed significant p-value (<0.001) for each of these observations [Table/Fig-3].

	Group A (n=34)	Group B (n=33)	Group C (n=33)
Mean age (days)	2.75	5.91	8.15
Mean weight (kg)	2.23	2.19	2.58
ICU stay (days)	8.96	7.82	1.42
Ward stay (days)	1.39	2.38	4.45
Ventilator dependent days	5.12	1.23	0.03

[Table/Fig-1]: Mean age (days), weight (kg), ICU stay, ward stay and ventilator dependent days per neonate.

Thrombophlebitis Grade	Group A (n=34)	Group B (n=33)	Group C (n=33)
I	8	19	10
II	12	5	1
III	11	7	0
IV	3	2	0

[Table/Fig-2]: Grade and severity of thrombophlebitis.

Parameter	Group A	Group B	Group C	p-value
Venepuncture sites	9	6	2	<0.001
Peripheral cannula used	4	3	2	<0.001
Peripheral cannula wasted	3	2	0	<0.001
Time spent in cannulation (minutes)	93.78	59.85	26.51	<0.001
Total cost of cannulation (rupees)	870	603.88	232	<0.001

[Table/Fig-3]: Number of venepuncture sites, number of peripheral cannula opened, used and wasted, time spent on IV cannulation and total cost of IV cannulation per neonate. All values are expressed as median except time and total cost of cannulation which are expressed as mean.

DISCUSSION

Vascular access in neonates requires skill, time, patience and the appropriate equipment. Sick neonates and those who require long ICU stay may suffer significant morbidity related to IV cannulation.

Gupta P et al., conducted a study in 78 newborns in whom 186 peripheral intravenous cannulae were inserted for IV therapy with median survival time (time duration in which cannula was in use without complication) was 40 hours [1]. Out of these 25 cannulae were removed selectively, and 84, 50, 17, and 10 were removed for swelling, dislodgement/leakage, blockage, and local erythema, respectively. Birth weight, gestational age, and fluid and glucose infusion rate, did not influence the median life span of cannulae.

McCallum L et al., found that infection and phlebitis are the complications of primary concern following IV cannulation and risk of complications increases with time [2]. Bai X et al., observed 47% incidence of phlebitis with use of peripheral IV cannula [3].

In our study, 399 peripheral venous cannulae were inserted in 100 neonates. Severity of thrombophlebitis was more in Group A and B. More severe grades were associated with prolonged ICU stay and ventilator dependent days. Peripheral venous cannulae were removed selectively in 41 neonates due to blockage, in 39 neonates due to thrombophlebitis and in 20 neonates due to extravasation, leakage, non requirement and prior to discharge.

Periard et al., compared the safety, efficacy, comfort, and cost-effectiveness between Peripherally Inserted Central Catheters (PICC) and peripheral intravenous cannulae in 60 patients [4]. He concluded that PICC is efficient and satisfying for hospitalized patients requiring IV therapy for more than five days and remains an interesting alternative for patients with few forearm IV access possibilities, patients requiring numerous blood investigations and patients requiring prolonged IV access when compared with

peripheral intravenous cannula. He also observed that mean number of venepuncture were 1.36 in the PICC group and 8.25 in the peripheral intravenous cannula group.

In our study, patients in Group A and B required longer hospital stay and more number of venepuncture sites. Median value for venepuncture site were 9, 6 and 2 in Group A, B and C respectively, in view of prolonged duration of IV therapy and short life span of IV cannula due to occlusion and phlebitis.

Bai X et al., studied cost-effectiveness of peripheral intravenous cannula and PICC in 53 patients and concluded that PICC is cost-effective compared to peripheral intravenous cannula for patients unable to get access to short-term intravenous catheter and those who need long period hospitalization in view of need for frequent replacement as a result of occlusion and phlebitis [3].

With time, as peripheral venous access sites become increasingly difficult to secure, considerable wastage of cannulae can occur due to shearing, damage or inability to thread during insertion attempts. We attempted to calculate the cost of peripheral venous calculation by adding up the cost of cannulae opened per patient. Total cost of peripheral IV cannulae per neonate was 870, 603.88 and 232 rupees in Group A, B and C respectively.

Stovroff M et al., commented that peripheral IV cannulation is a time consuming procedure. We observed that as hospital stay of our neonates increased, IV access sites became increasingly difficult to secure, which had a considerable impact on the time taken for cannulation. In our study, median time spent per neonate was 60, 35 and 20 minutes in Group A, B and C respectively [6].

Anisworth SB et al., noted that the use of a percutaneous centralvenous catheter resulted in decreased number of peripheral venous cannulae needed to deliver nutrition without increased risk of adverse events, particularly systemic infection [7].

Loisel DB et al., concluded that patients having umbilical venous catheter during first two weeks of life had significantly fewer venepunctures, less time and money spent on cannulation than patients having peripheral intravenous line only [8].

Our study has few limitations. We studied thrombophlebitis as a single important outcome of interest. However, we have also audited other complications of peripheral venous cannulation like blockage, extravasation and leakage as a cause for peripheral venous cannula removal. Secondly, we did not perform a comparative study between peripheral venous cannulation and other available vascular devices e.g., peripherally inserted central catheters, central venous catheters. This was because; peripheral venous cannulation is the standard practice in our institute. The strength of our study is that it addresses the problems of intravenous cannulation of longer duration in a large sample size. It can also form the base for change in resource utilization policy, particularly in institutes where use of peripheral intravenous cannulation is a routine practice.

CONCLUSION

Peripheral venous cannulation of long duration is associated with significant neonatal morbidity, is costly, and time consuming. Neonates with long ICU stays are prone to develop severe thrombophlebitis, necessitating new venous access sites. In this group of patients, it may be worthwhile to consider alternatives such as peripherally inserted central catheters or central venous catheters.

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FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Aug 17, 2016**
Date of Peer Review: **Oct 25, 2016**
Date of Acceptance: **Nov 19, 2016**
Date of Publishing: **Mar 01, 2017**