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Intermittent flushing improves cannula patency compared to continuous infusion for peripherally inserted venous catheters in newborns: results from a prospective observational study

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Abstract

Aims: Peripheral cannulas in newborns are commonly used for intravenous treatment. However sustained maintenance of cannula patency is often difficult to achieve in this age group. This study compares the duration for which cannula patency can be maintained in newborns under continuous infusion, or an intermittent flushing regimen, with normal saline.
Methods: A prospective observational study was conducted during a 12-month period. All newborns admitted to the 16-bed intermediate care unit, who required intravenous treatment, received either continuous peripheral infusion with 0.9% saline at an infusion rate of 2 mL/h or an intravenous cannula, which was flushed with 1 mL of 0.9% saline at least once every 24 h.
Results: A total of 53 patients with 86 cannulas were included. Twenty-five (47%) patients received 41 continuous infusions. The intermittent flushing group consisted of 28 (53%) patients with 45 cannulas administered. The cannula patency was significantly longer in the intermittent flushing group (mean 62.1 vs. 92.8 h, P=0.01). The patient's underlying disease and the cannula insertion site were not related with the duration of the cannula patency.
Conclusions: Our study shows that intermittent cannula flushing is associated with improved cannula patency for peripherally inserted venous catheters in newborns.

Keywords: Cannula patency; continuous infusion; intermittent flushing; newborns; peripheral intravenous catheter.

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Introduction

Peripheral cannulas are commonly used in newborns for the intravenous application of fluids and drugs. Intravenous cannulation and therapy with continuous infusion may require the newborn to be separated from its mother and can delay the establishment of maternal infant bonding [4, 9]. In newborns requiring drug administration, but no continuous fluid therapy, intermittent use of the cannula enables intravenous treatment in an ambulatory setting, which prevents separation of mother and newborn and alleviates the necessity of the parent's presence in the ward. Repeated venous access can be difficult to achieve in this patient group over time and is a stressful experience for the newborn, the new parents and the medical staff [5, 10]. Therefore, sustained maintenance of cannula patency is an imperative for prolonged intravenous treatment. Not much information on the different means of maintaining intravenous cannula patency is available in the literature. In a Cochrane review in 2005, Flint et al. focused on factors that influence the longevity of venous peripheral access and compared the outcome of continuous infusion to that of intermittent flushing. They were not able to establish that either method was superior to the other [1].

The primary goal of the present study was to compare the duration of initial cannula patency under continuous infusion, in comparison to intermittent flushing with normal saline solution. In addition, the total number of cannulas inserted, the duration of total cannula patency, role of the underlying disease, weight and age of the newborn, as well as the cannula insertion site were investigated.

Patients and methods

The present prospective observational study analyzed the impact of two different treatment regimes on the patency of peripherally inserted venous cannulas in newborns. The study was conducted in the 16-bed neonatal intermediate care unit of a university teaching children's hospital during a 12-month period using a convenience-based sampling strategy. The study was approved by the local Ethical Committee.

During the first 6 months of the study (July–December 2008), all newborns admitted to the unit who required intravenous treatment, received continuous peripheral infusion with 0.9% saline, at an infusion rate of 2 mL/h. During the course of the following 6 months (January–July 2009) all admitted newborns requiring peripheral injection of drugs were treated via an intravenous cannula, which was flushed with 1 mL of 0.9% saline at least once every 24 h. If the newborn required antibiotics, the cannula was flushed with 1 mL saline after each drug application, respectively every 8 h. In all cases

a 24-gauge, 19 mm long peripheral catheter (Insyte-N BD, Becton Dickinson, Allschwil, Switzerland) was used with a 10 cm long syringe pump infusion line (Syramed line, Arcomed AG, Switzerland) and a three-way stopcock (Discofix C-3, Braun AG, Switzerland). All cannulas were secured and controlled according to the hospital protocol, including fixation on a splint if the cannula was inserted in the back of the hand, foot or crook of the elbow. For each treatment regimen the following measures were noted: gestational age, age at insertion of first cannula, being born small for gestational age (SGA), weight of the newborn, underlying disease, date and time of cannula insertion, insertion site, date, time and reason of cannula removal. For the statistical analysis, the cannula insertion site was defined as "distal", corresponding to the back of the hand or foot vs. "proximal", corresponding to the crook of the elbow or scalp. Concerning the newborn's underlying disease we only investigated whether or not sepsis was present during the investigation period. Sepsis was defined as the presence of positive blood cultures, clinical signs with temperature instability, mottled or pale skin, irritability and signs of infection in the blood sample. We focused on the influence of sepsis on cannula patency and removal, suggesting that a patient with sepsis and therefore bacteremia might be more susceptible to develop phlebitis and/or local infection at the site of foreign material in his blood stream.

Statistics

Statistical analysis was performed with SPSS, Version 16.0, using the Mann-Whitney non-parametric test for independent samples and multiple linear regressions for risk factor analysis with a statistical significance defined by $P<0.05$.

Results

During the first 6-month study period, 25 patients receiving a total of 41 continuous infusions were included. During the second 6-month period, 28 patients with a total of 45 cannulas were included, the intravenous cannula being intermittently flushed with 0.9% saline. Gestational age was equally distributed among the two treatment groups (P=0.43) and there was no difference with regard to newborns being born small for gestational age (SGA) between the two treatment groups (intermittent flushing group: 1/28, continuous infusion group: 2/25; P=0.60). Gestational age and SGA showed no statistically significant effect on duration of cannula patency when entered into the regression analysis (P=0.32 and P=0.47, respectively). There were no differences in body weight or time of initial cannula insertion between the two treatment groups (Table 1A). There were significantly more sepsis patients in the intermittent flushing group (71.4%) than in the group treated with continuous infusion (40%; P=0.03). The initial insertion of the intravenous cannula in both groups took place at the back of the hand (n=31) or foot (n=10), in the crook of the elbow (n=7) or in the scalp (n=5) and there was no statistically significant difference between the two treatment groups with respect to insertion site of the initial cannula (P=0.18). There was also no statistically significant difference in the total number of employed cannulas between the treatment groups (P=0.51). Inserted cannulas were removed for reasons of infiltration/extravasation, occlusion, phlebitis or because they were no longer required. There was no difference in reasons for loss of function for the initially inserted cannulas between the treatment groups (P=0.11). In the continuous infusion group the reasons for loss of cannula function were distributed as follows: 14 (56%) infiltration, 3 (12%) phlebitis, 2 (8%) occlusion and 6 (24%) intact cannula removal, because it was no longer required. The corresponding figures for the intermittent flushing group were: 12 (42.9%) infiltration, 2 (7.1%) occlusion and 14 (50%) intact cannula removal, because it was no longer required.

The cannulas employed in the intermittent flushing group retained their patency for a significantly longer period than did those employed in the continuous infusion group, with respect to both the initially inserted and the total number of

Table 1A Demographic data and main results for the initial cannula per patient.

	Treatment group		P-value
	Continuous infusion (n=25)	Intermittent flushing (n=28)	
Patient weight in g (mean±SD)	3375±814	3435±588	0.85
Patient age at first cannula in days (mean±SD)	12.1±9.5	14.5±8.2	0.28
Cannula insertion site			0.18
Distal site (n/%)	21/84	27/96.4	
Proximal site (n/%)	4/16	1/3.6	
Sepsis (n/%)	10/40.0	19/71.4	0.03
Cannula patency in hours (mean±SD)	62.1±44.3	92.8±55.7	0.01

Table 1B Main results for the total of cannulas per patient.

	Treatment group		P-value
	Continuous infusion (n=41)	Intermittent flushing (n=45)	
Sepsis (n/%)	19/46.3	33/75.0	0.016
Cannula patency in hours (mean±SD)	53.9±38.0	85.4±56.5	0.002

cannulas per individual patient (P=0.01 and P=0.002, respectively: Tables 1A and 1B). The Kaplan-Meier curve depicts the statistically significant difference in the duration of cannula patency between the two treatment regimens (log rank test 0.032: Figure 1). Cannula insertion site, gestational age, being born SGA, age and weight of the newborn, had no effect on the longevity of cannula patency (P=0.44, P=0.32, P=0.47, P=0.51 and P=0.46, respectively). Sepsis did not influence the duration of cannula patency (P=0.37).

Discussion

The aim of the present study was to compare the duration of peripheral venous cannula patency in newborns under two different conditions (continuous infusion vs. intermittent flushing). We could demonstrate that patency was retained for a significantly longer duration upon intermittent flushing than upon continuous infusion. This increased longevity applied to both the initially inserted cannula as well as to the total number of applied cannulas per individual newborn.

A Cochrane review published by Flint et al. in 2005 included the only two controlled randomized trials comparing continuous infusion with intermittent flushing, in order to prevent loss of function of peripheral intravenous cannulas in newborns requiring drug administration [1]. One of the included studies describes similar duration of cannula patency in both treatment groups for the first cannula used per newborn. However, almost twice as many cannulas were used in the continuous infusion group compared to the intermittent flushing group [2]. In the second randomized trial, patency duration of the first cannula used per infant was not reported. The duration of cannula patency was, in accordance with our findings, significantly longer in the intermittent flushing group (P-value=0.0003), for all catheters averaged during the treatment course. The mean number of catheters used, defined for the first 48 h of treatment, was significantly higher in the continuous infusion group [8]. In conclusion, the data of the Cochrane review were not able to establish that either method was superior to the other [1], but the results support the use of intermittent flushing with saline 0.9% in newborns requiring drug administration. This is in accordance with our findings.

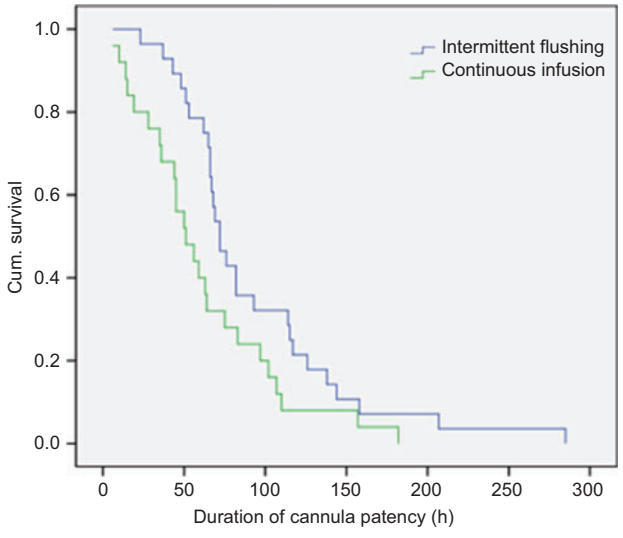

Figure 1 Kaplan-Meier survival curve for duration of cannula patency in hours.

Similar results were also reported in a retrospective cohort study conducted in 2003. Flint et al. compared the duration of cannula patency for continuous infusion vs. intermittent flushing in term newborns requiring intravenous medication only. Their study design was very similar to ours even though the flushing interval was shorter than in our study (6 h vs. 8–24 h, respectively). The study demonstrated that intravenous cannulas last just as long if they are flushed intermittently with sodium chloride and do not have a continuous infusion running. After the intermittent flushing regimen was established, the authors report the observation of various benefits including easy access for mothers to initiate early feeding, greater involvement of parents in infant care, potential cost savings, and enhanced maternal-infant bonding.

In our study, the reasons for loss of function for the first cannula used per newborn were similarly distributed between the two treatment groups. This is in contrast to the findings of both studies included in the Cochrane review. Kalyn et al. report a statistically significant difference (P-value <0.001): in the intermittent flushing group catheters were less likely to infiltrate, leak or develop phlebitis whereas in the continuous infusion group they were less likely to occlude [2]. Taylor et al. [8] focus on extravasation, defined as the number of infiltrations per day. They report the mean of infiltrations a day to be significantly higher in the continuous infusion group compared to the intermittent flushing group (P-value=0.0015).

When we analyzed the newborns' underlying disease in our study, there were significantly more sepsis patients in the intermittent flushing group compared to the continuous infusion group. However, no difference was shown in the reasons for loss of cannula function for the first cannula used per newborn between the two treatment groups. Furthermore, sepsis did not influence the duration of cannula patency.

A number of trials have investigated the role of heparin in peripheral venous catheters of the newborn [3, 6, 7]. No heparin was used in either of our treatment groups, thus this was no object of investigation.

One limitation to our study is that we investigated two different treatment methods in two separate time periods, which could possibly lead to a bias due to unrecognized temporal changes on our intermediate neonatal care unit. However, even if subtle changes over time cannot be completely excluded, there were certainly no major shifts in staff and/or treatment policies on the unit during the 12-month period of investigation.

The conclusion which can be drawn from the results of our study and with respect to previously published data [1, 2] in the literature is the following: intermittent cannula flushing may be associated with increased duration of cannula patency for peripherally inserted venous catheters in newborns. This application modus has not shown any disadvantages and potentially allows intravenous treatment in an ambulatory

setting. The current data support the use of intermittent flushing of cannulas in selected populations of neonatal nurseries requiring drug administration only. However, in order to establish a new gold standard of care for peripheral venous cannulation in newborns, adequately powered randomized controlled trials will be needed.

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