Venipuncture versus heel prick for blood glucose monitoring in neonates

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ABSTRACT

Introduction: The aim of this study was to determine whether there was a difference in the pain indicators and effectiveness between venipuncture (VP) and heel prick (HP) for blood glucose monitoring in term neonates (recently, venipuncture was shown superior for the Guthrie test).

Methods: 66 term neonates undergoing blood glucose monitoring underwent VP or HP. Primary outcome measures included the Neonatal Facial Scoring System (NFCS) score, duration of the first cry, total duration of cry and duration of procedure. Secondary outcome measured was the number of skin punctures needed to obtain blood.

Results: The NFCS score was not significantly different between the two groups and the duration of the procedure was significantly longer for the VP than the HP group (median 27 s vs. 7 s; p-value is less than 0.001). The differences between the two groups in the duration of the first cry, total duration of cry and number of skin punctures needed to obtain blood were not statistically significant, but these parameters displayed a trend, favouring the HP.

Conclusion: The HP is still the preferred method of drawing blood in neonates for blood glucose monitoring, as only one drop of blood is required.

Keywords: blood glucose monitoring, heel prick, Neonatal Facial Scoring System score, venipuncture

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INTRODUCTION

Blood-taking for babies in the Neonatal Intensive Care Unit (NICU) or special care nursery is a common event that causes pain to the newborns. Recent studies have proven that the anatomical, physiological and neurochemical structures that convey pain are well developed in neonates[1] and that babies' early pain experience may alter their pain response in later life.[2] Many attempts have been made to reduce the pain sensation in the neonates undergoing blood-taking. One of the most studied methods is the administration of sucrose[3] or dextrose[4] before the blood prick, which has been shown to effectively reduce pain sensation in neonates.

Methods of blood-taking may also play a role in reducing pain. Previously, the heel prick (HP) method was believed to be superior to venipuncture (VP) for the Guthrie test or for the serum bilirubin test. However, when proper studles were conducted, it was found that the use of VP was shown to be less painful and more effective for neonates than the HP.[5-7] At least four drops of blood are required for both the Guthrie and serum bilirubin tests. If only one drop of blood is required, the HP is still considered the preferred method of blood-taking, but to the best of our knowledge, there has not been any study done to determine whether VP could also be the preferred method in neonates when the required amount of blood is only one drop, as in blood glucose testing. The aim of this study was to determine whether there is a difference in the indicators of pain sensation and effectiveness between VP and HP for blood glucose monitoring, requiring only one drop of blood in term neonates.

METHODS

A controlled trial was conducted at the NICU of Hospital Universiti Sains Malaysia, a tertiary hospital in Malaysia, from June 2006 to July 2006. Full-term neonates admitted to the NICU and requiring blood glucose monitoring within the first two weeks of life, were eligible for this study. Neonates with congenital abnormality or serious illness were excluded. Neonates receiving sedation less than 24 hours prior to blood-taking and who cried immediately before the skin puncture were also excluded.

No probability sampling was done. Neonates were allocated to either the VP Group or the HP Group depending on the availability of the assigned staff; two senior paediatric registrars were assigned to do the VPs and a single experienced staff nurse was assigned to do

Table I. Characteristics of neonates in the venipuncture and heel prick groups.

Variables	Venipuncture group (n = 30)	Heel prick group (n = 30)	p-value
Birth weight* (g)	3,158 ± 645	3,066 ± 636	0.580
Gestational age* (weeks)	39 ± 1	40 ± 2	0.788
Postnatal age* (days)	4 ± 3	5 ± 6	0.425
Apgar score for five minutes*	9 ± 0.5	9 ± 1.5	0.337
Gender†			
Male	18 (60)	20 (66)	0.287
Female	12 (40)	10 (33)	
Mode of delivery†			
Vaginal	18 (60)	16 (53)	0.271
Caesarean	12 (40)	14 (47)	

* expressed as mean ± standard deviation; independent *t*-test
† expressed as no. (%); chi-square test

the HPs. Needle size 23G was used for the VP and an automatic disposable lancing device, Unistik 2 Neonatal (Omega Healthcare, London, UK), was used to do the HP. In both groups, the neonates were fed 1–2 hours before testing and were sleeping or awake and resting while being tested. The skin of the test area was then warmed for one minute by placing the neonate's hand or heel between the warm hands of the nurse or registrar. Immediately before the prick, the babies were given 2 ml of 25% dextrose orally via a sterile syringe. The test area was cleaned with a disinfectant and the skin was punctured. The duration of the procedure was timed. The study hypothesis was that the VP would be more efficacious and less painful than the HP.

The primary outcome measures included the Neonatal Facial Scoring System (NFCS) score,[3] duration of the first cry, total duration of cry and duration of the procedure. The secondary outcome measured was the number of skin punctures needed to obtain blood. The facial reaction was recorded with a video camera, SONY DV8 (Sony Electronic Inc, Park Ridge, NJ, USA), by focusing the video camera specifically on the face. The video recording commenced from the moment the skin was punctured until one minute after the crying stopped. Two independent observers who were blinded to the method of blood-taking assessed the NFCS using a personal computer with Windows Media Player (Microsoft Corporation, Redmond, WA, USA). Before the assessment, they were trained for two hours using a test video clip, and a trial run was performed. The observers assessed the data independently and were not allowed to discuss their observations with each other.

The NFCS was performed according to the method described by Grunau and Craig.[8] The facial reactions were analysed during the first 15 seconds after the skin was punctured. The observation period was divided into 15 one-second intervals. The presence or absence of the nine variables during each interval was recorded. The range for each variable was between 0% and 100%. The total NFCS was presented as the sum of all the nine variables with a range of 0%–900%. The mean score for each neonate was calculated, and the facial action coding system[9] was used to calculate interobserver reliability. The video clip was viewed to determine the duration of the first cry and total duration of cry. Cry was defined as an audible vocalisation, and the total duration of crying was taken as the total sum of audible cry during the period of recording. The total duration of the procedure was determined using a stopwatch during the procedure and was defined as the time taken from the moment the skin was punctured until one drop of blood was placed on the strip of the glucometer. The number of skin punctures needed to complete the procedure was also recorded.

The required sample size was calculated by two proportions comparison equation,[10] using the proportion of the median NFCS score for the number of skin punctures in the VP Group and HP Group.[7] The estimated differences were based on a previous study by Larsson et al.[7] A sample size of 33 for each study group was needed to achieve a power of 80%, with a significance level of 0.05. Data entry and analysis were performed with the Statistical Package for the Social Sciences version 12.0.1 (SPSS Inc, Chicago, IL, USA). The differences in NFCS scores, duration of the first cry, total duration of cry, and duration of procedure in both study groups were compared using the Mann-Whitney U-test. The number of skin punctures needed to obtain one drop of blood in both groups were compared using the Fisher's exact test. Written informed consent was obtained from the parents or caretakers before inclusion in the study, and ethical approval for the study was obtained from the research and ethical committee of Universiti Sains Malaysia.

RESULTS

A total of 66 neonates were studied. Six neonates,

Table II. Outcome measures in the venipuncture and heel prick groups.

Variables	Venipuncture group		Heel prick group		p-value
	Median (range)*	No. (%)	Median (range)*	No. (%)	
NFCS score	163 (0–560)	30	157 (0–560)	30	0.882
Duration of the first cry (s)	11.2 (1–54)	15	7.0 (3–80)	14	0.646
Total duration of cry (s)	15.0 (2–54)	15	8 (3–80)	14	0.315
Total duration of procedure (s)	27.5 (8–31)	30	7 (4–20)	30	< 0.001
No. of punctures†					0.237
1		27 (90)		30 (100)	
> 1		3 (10)		0	

* Mann-Whitney U-test
† Fisher exact test

three in the VP Group and three in the HP Group, were excluded from the study because they cried just before the skin was punctured. These six babies had similar baseline characteristics as the study groups. Thus, there were 30 subjects in each group for the analysis. Table I shows the baseline characteristics for both groups. The median NFCS score in the VP Group was similar to the HP Group and was not statistically significant (163 vs. 157, p = 0.882). The inter-rater reliability was 80% for all the neonates studied. 50% (15/30) of the neonates in the VP Group and 46.7% (14/30) of the neonates in the HP Group cried after the first skin puncture. The differences between the two groups in the duration of the first cry and the total time the neonates cried during the procedure were not significantly different (Table II). The median total duration of the procedure in the VP Group was significantly longer than that in the HP Group, 27.5 (range 8–31) seconds vs. 7 (range 4–20) seconds; p < 0.001. Three babies in the VP Group, but none in the HP Group, required more than one skin puncture; but this difference was not significant (Table II). No adverse events occurred during or after the blood-taking.

DISCUSSION

In this study, the total duration of the procedure was significantly longer in the VP Group than in the HP Group. There were no significant differences found in the NFCS score, the duration of the first cry and the total duration of cry. These results suggest that VP is not superior to HP for blood-taking in the neonate, if the amount of blood required is only one drop. The most likely reason for this is because there is a minimal need for squeezing the heel when such a small amount of blood is required and that failure to obtain an adequate amount of blood through one HP is much less likely than when four or more drops of blood are required, such as for the Guthrie or the bilirubin tests. Furthermore, blood glucose testing often needs to be made repeatedly for neonates and this could render each subsequent VP more difficult. On the other hand, repeated HP may also be increasingly painful for babies.

Randomisation was attempted, but due to the limited availability of the staff assigned to take the blood, the random allocation to either procedure had to be abandoned very early in the study. This may have introduced a certain level of bias, but the decision to include eligible neonates in the study was made prior to checking the availability of the staff, by a person who was not involved in the care of the babies up to that point in time. However, the validity of the study results was unlikely to be affected by this. The pain due to blood-taking depends on many factors. Besides the method of blood-taking, the environment of the baby and the administration of sweeteners before the prick have been shown to have a significant effect on the sensation of pain.[3,4] For the purpose of this study, the environment was standardised for each patient, and all patients received dextrose solution just before the prick. Dextrose solution has been shown to be similarly effective as sucrose and was used in this study for practical reasons.[11] It was administered immediately before the prick in order to prevent a false high reading of the capillary blood sugar due to absorption of the dextrose. The short time interval between the administration of the sweet solution and the blood-taking may have limited its effectiveness to stimulate endorphine production, but orotactile stimulation[12] has also been found to reduce pain sensations.

The skill of the staff taking the blood may have played a role as well.[7] To minimise the effect of this factor, the HPs were done only by one experienced staff nurse and the VPs were performed by two experienced senior paediatric registrars. It has been previously shown that blood-taking for an amount as small as four drops (required for the Guthrie test or serum bilirubin test) may be best done via a VP.[7,13,14] The results of the current study, however, suggest that this statement cannot be extrapolated when smaller amounts of blood are to be taken. In conclusion, this study suggests that the VP is not superior to the HP for blood-taking in neonates if only

one drop of blood is required, as in the determination of the blood glucose level.

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