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What influence does experience play in heel prick blood sampling?

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Experience

Abstract The objective of this study was to investigate the role of 'experience' in performing the heel prick test. Babies ($n = 340$) were randomly allocated to be tested with either the Tenderfoot or Genie Lancet heel prick device. Testing was conducted by nine midwives ($n = 4$, experienced, more than 20 years qualified) who performed the heel prick procedure routinely and rotational midwives ($n = 5$, less experienced, 4–8 years qualified) who only performed the heel prick procedure when working in the community. Test technique outcomes investigated included (1) cleaning of heel, (2) babies position, (3) feeding at test, (4) use of soothing words. Other test outcomes (1) quality of the blood sample, (2) number of heel pricks required to take sample, (3) blood flow, (4) presence of bruising (5) time taken to collect sample, (6) time squeezing the heel and (7) time baby cried were also studied. The experienced midwives were more likely to hold the baby during testing but less likely to clean the infants heel prior to the incision. The experienced midwives collected a better quality sample, in less time and required fewer heel pricks than the less experienced midwifery group.

The heel prick test is routinely taken within the first 10 days of life usually by the community midwife. Despite the relative ease of the heel prick procedure compared to other blood sampling methods, problems still exist including pain for the infant (Sheeran, 1997), anxiety for the parents (Meehan, 1998), complications arising from mild bruising and haematomas (Fleischman, 1992), calcaneal osteomyelitis (Abril et al., 1999; Fleischman, 1992) and cost arising from the need to repeat the test (Grant and Muller, 1993).

The procedure used by midwives today is similar to that followed when the heel prick test was first introduced despite research findings which contradict many of the steps (Shepherd et al., 2004). New guidelines issued in April 2005 suggest that pre-warming of the foot is not essential and that the sample should be taken from a clean heel (UKNSPC, 2005).

A recent study has highlighted great variability in the heel prick technique among midwives

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(Cavanagh et al., 2005). One possible reason for this is that the procedure is predominantly taught by midwife mentors, who teach their own preferred method (Cavanagh et al., 2005). Due to this, the need for the heel prick test to be accredited and for midwives to obtain a certificate of competence has been voiced (Spiel, 1997).

Objective

The main purpose of this study was to investigate the effectiveness of two heel prick devices. An important aspect to the effectiveness of heel prick testing is the experience of the midwife conducting the test. Thus, the purpose of this paper is to determine the influence of midwives' experience of heel prick blood sampling on technique and a number of outcomes including the quality of the blood sample, the number of heel pricks required, blood flow, presence of bruising, time taken to collect the sample, time taken squeezing the heel and the time the baby cried. Preparation of the heel, position of baby during testing and the use of soothing words were also noted.

Participants and design

Approval was granted by the Ethics Committee of the Department of Nursing and Midwifery, University of Stirling, and the local NHS Research Ethics Committee. The sample was drawn from babies born between April and November 2003, in one NHS hospital in Scotland with approximately 1700 deliveries per year.

Healthy babies born at full-term (from 37 weeks gestation), including multiple births, were eligible for entry to the study. Parents were given an information sheet which detailed the study prior to discharge. Due to the introduction, 3 months into the study, of team midwifery in favour of community or hospital based midwives, the number of midwives conducting the heel prick test increased. This led to a reduction in the number of tests the researcher could observe. In order to maximize our sample number, the researcher followed which ever midwife had the largest caseload of tests that day. All parents approached ($n = 341$) had the opportunity to ask the researcher any questions before agreeing to participate and giving their signed consent ($n = 340$).

A randomisation series was computer-generated to allocate the babies into groups (Fig. 1). As the main purpose of the study was to evaluate the effectiveness of two heel prick devices in relation to the quality of blood sample obtained, half of the babies were tested with the Genie Lancet device ($n = 169$) and half were tested with the Tenderfoot device ($n = 171$). To address the hypothesis that heel heating is not required when using the Tenderfoot device, half of these babies had their heels heated prior to the heel prick ($n = 86$) and the other half had no heel heating ($n = 85$). The randomisation scheme was independently prepared by the Computing Science and Mathematics Department of the University of Stirling and delivered to the research assistant in the form of sequentially numbered, sealed opaque envelopes which contained allocation to the appropriate group.

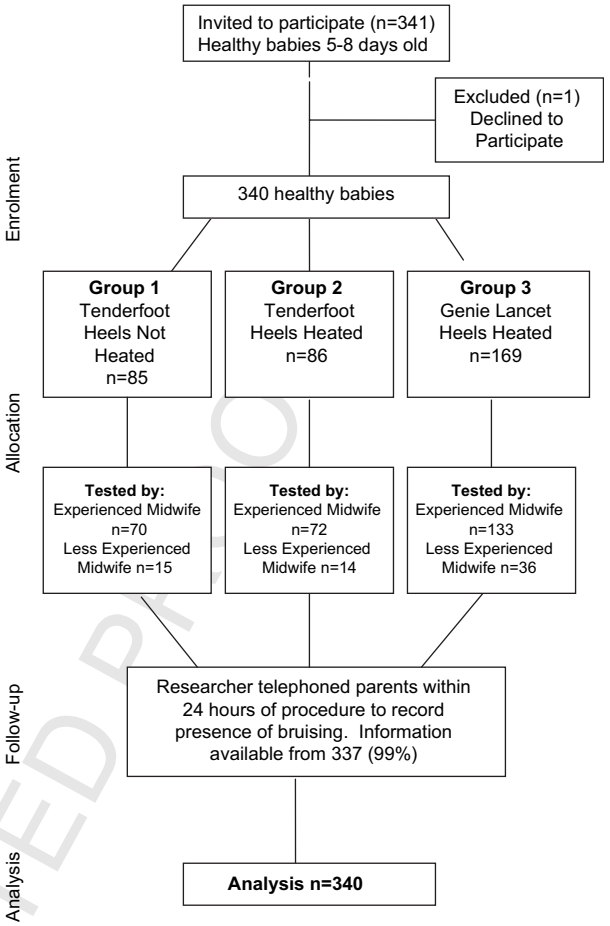

Figure 1 Study profile.

The nine midwives observed were categorised into two groups: community midwives ($n = 4$, experienced, more than 20 years qualified) who performed the heel prick procedure routinely and rotational midwives ($n = 5$, less experienced, 4–8 years qualified) who only performed the heel prick procedure when working in the community.

Main outcomes

All blood samples collected were graded (Table 1) in the Scottish Newborn Screening Laboratory, Yorkhill NHS Trust, Glasgow by one technician who was blind to the study group allocation and the midwife taking the sample. Time to collect the sample (from heel prick to midwife declaring the sample complete) and length of time squeezing (whether intermittent or constant) were measured using a stop-watch.

The number of heel pricks and any squeezing required were recorded at the time of the blood sampling. The pain expressed by the baby, was assessed by the duration of crying. The whole procedure was audio taped and the length of time the baby cried noted.

The researcher recorded if the midwife cleaned the baby's heel prior to the incision, and if so, what she used. She also noted if the midwife squeezed the heel and whether the blood flowed freely from the heel. The position of the baby during testing and whether the midwife encouraged feeding, skin-to-skin contact between mother and infant or used soothing words to the infant during testing was noted.

Data were collected by one research assistant who observed nine midwives undertake the test. Data were collected from 5 to 8 day old babies. Heel prick procedures for both devices were performed according to the manufacturer's instructions.

Once the parent consented to take part in the study, the baby was randomly allocated a group. Group two (Tenderfoot heated) and three (Genie Lancet) then had their heels heated for 10 min, using a baby gel heel warmer (WarmGel Infant Heel Warmer, Prism Technologies, Inc, San Antonio, Texas) activated to a temperature of 40°C, folded around the foot and secured with tape. Audio taping started prior to the heel prick to measure the length of time the baby cried. The timing of the sample collection began immediately the heel prick was performed and ceased when the midwife declared the sample was sufficient for testing.

Parents were telephoned 1 day after testing and asked whether any bruising was present on the baby's heel at the puncture site. A more objective measure of bruising was precluded by time constraints.

Table 1 Classification of blood samples

Grade 1	Insufficient blood to perform test, repeat sample required
Grade 2	Sufficient to perform all current tests[a]
Grade 3	Sufficient blood to perform all current tests,[a] plus sufficient blood to retest within SNSL, in case of technical fault or ambiguous result
Grade 4	Sufficient blood to perform all tests, all retests, and sufficient blood to send to molecular laboratory for diagnosis of cystic fibrosis[b]

[a] Phenylketonuria (PKU), measured by phenylalanine; congenital hypothyroidism (CHT), measured by thyroid stimulating hormone (TSH); screening for cystic fibrosis (CF), measured by immuno reactive tripsinogen (IRT).
[b] Samples with raised levels of IRT are forwarded for molecular analysis and diagnosis of CF.

Data analysis

SPSS (version 11) was used for all data analysis. Analysis was conducted using Chi-squared, Fisher's exact and Mann–Whitney *U* tests. Observed values for outcome variables are not completely independent as it was not possible to have a different midwife test each baby. As such, the data and observations collected from the nine individual midwives were assumed to be independent and for analysis, any potential clustering effect due to individual midwives was ignored.

Results

The researcher observed nine midwives ($n = 4$, experienced; $n = 5$ less experienced) undertake 340 heel prick procedures (Fig. 1).

Technique

Cleaning

Only 3.8% of babies ($n = 13$) had their heels cleaned (all with alcohol wipes) before the heel prick. A significant difference between experience groups and whether the heel was cleaned was noted ($p = 0.02$, Fisher's exact test). The experienced group cleaned 2.5% of babies heels ($n = 7$) compared with 9.2% of babies ($n = 6$) in the less experienced midwives group.

Baby's position

Chi-squared analysis indicated a significant difference between the baby's position and midwife experience group (Table 2). The experienced midwives were more likely to hold the baby during testing (62.5%) compared with asking the parent to hold the baby (14.2%) or for the baby to be tested in a pram/cot or on a mat (23.3%). The less experienced midwives were more likely to ask the parent to hold the baby (38.5%) than the experienced group.

Table 2 Midwifery group versus technique

	Experienced midwives, *n* (%)	Less experienced midwives, *n* (%)
Baby's position ($\chi^2 = 21.1$, df = 2, $p < 0.0001$)		
Held by parent	39 (14.2)	25 (38.5)
Pram/cot/mat	64 (23.3)	14 (21.5)
Held by midwife	172 (62.5)	26 (40)
Feeding at test ($\chi^2 = 7.9$, df = 1, $p = 0.005$)		
Yes	29 (10.5)	16 (24.6)
No	246 (89.5)	49 (75.4)
Skin to skin contact (χ^2=5.2, df = 1, $p = 0.02$)		
Yes	25 (9.1)	13 (20)
No	250 (90.0)	52 (80)
Use of soothing words ($\chi^2 = 2.6$, df = 1, $p = 0.1$)		
Yes	53 (19.3)	19 (29.2)
No	222 (80.7)	46 (70.8)
Position of heel in relation to body ($\chi^2 = 37.7$, df = 2, $p < 0.0001$)		
Higher than trunk	39 (14.4)	1 (1.5)
Lower than trunk	15 (5.5)	19 (29.2)
Level with trunk	221 (80.4)	45 (69.2)
Heel squeezing ($\chi^2 = 3.4$, df = 1, $p = 0.06$)		
Yes	160 (58.2)	29 (44.6)
No	115 (41.8)	36 (55.4)

A significant difference was also noted between the two midwifery groups and the position of the baby's heel (Table 2). Only 5.5% ($n = 15$) of the babies tested by the experienced midwives had their heels lower than their trunks compared with 29.2% ($n = 19$) of babies tested by the less experienced midwives.

Feeding at time of test

Chi-squared analysis indicated a significant difference between the two midwifery groups and whether the baby was feeding while being tested (Table 2). Babies in the less experienced midwifery group were more likely to be feeding (24.5%) than those tested by the more experienced midwifery group (10.5%). This is likely to relate to the use of mother–baby skin-to-skin contact which was evident in 20% of the babies in the less experienced midwife group compared with 9.1% of the more experienced midwife group. This difference was shown to be statistically significant (Table 2).

Use of soothing words

No statistically significant difference was noted between midwifery groups and their use of soothing words. It is interesting to note however, that almost 30% of the less experienced midwives used soothing words compared with 19% of the more experienced midwives (Table 2).

Heel squeezing

No statistically significant difference was noted between midwifery groups and whether the baby's heel was squeezed (Table 2).

Other outcomes

There was no significant difference between the midwifery group and the device used. Therefore, all further analysis includes infants tested with both the Tenderfoot and Genie Lancet devices.

No tests had to be repeated (grade 1). Chi-squared analysis (combining quality of samples grades 2 and 3) indicated a significant difference in the quality of sample obtained and midwifery group with a higher percentage of samples from the experienced midwives in grade 4 (Table 3). Initial chi-squared analysis (combining all those who required more than one heel prick) indicated a significant difference in the number of heel pricks required at each test and the midwifery group with the less experienced midwives requiring significantly more heel pricks (Table 3).

No significant difference was noted between midwifery groups and whether the blood flowed freely from the incision or whether the midwife had to touch the heel with the card (Table 3).

Table 3 Midwifery group versus outcomes

	Experienced midwives, *n* (%)	Less experienced midwives, n (%)
Quality of sample ($\chi^2 = 5.3$, df = 1, $p = 0.02$)		
Grade 1	0	0
Grade 2	3 (1.1)	2 (3.1)
Grade 3	25 (9.1)	12 (18.5)
Grade 4	247 (89.8)	51 (78.5)
No heel pricks ($\chi^2 = 31.9$, df = 1, $p < 0.0001$)		
1	244 (88.7)	38 (58.5)
2	30 (10.9)	19 (29.2)
3	0	5 (7.7)
4	1 (0.4)	2 (3.1)
5	0	1 (1.5)
Blood flow ($\chi^2 = 0.2$, df = 1, $p = 0.6$)		
Free flowing	124 (45.1)	32 (49.2)
Touching card	151 (54.9)	33 (50.8)
Bruising ($p = 0.78$ Fisher's exact test)		
Yes	17 (6.3)	3 (4.6)
No	255 (93.8)	62 (95.4)

The presence of any bruising post heel prick was noted by parents who were contacted by the researcher 24 h after the test. Data were available for 337 (99%) babies (three families were not contactable by telephone after the test).

The number of babies with bruising present is shown in Table 3. No statistically significant difference between midwifery groups and the presence of bruising was noted.

As the following data were not normally distributed and could not be transformed to normality, the Mann–Whitney *U* test was conducted.

The mean time to complete the sample was significantly different between midwifery groups with the less experienced midwives taking significantly longer. No difference was noted between midwifery groups and the length of time the heel was squeezed and the length of time the infant cried (Table 4).

Discussion

The main aim of this study was to compare the effectiveness of two heel prick devices. The results presented here explore an important aspect to this study, that being the role of 'experience' in performing such a skill.

Our study has indicated that the less experienced midwives followed the guidelines provided (NHS Scotland, 2003), more closely. For example, these midwives were more likely to ask the mother to hold the infant, or to encourage feeding or use of skin-to-skin contact during testing. However, the outcomes in relation to the quality of sample, number of heel pricks and time to complete the sample were all in favour of the more experienced midwifery group.

One obvious limitation to this study is the difference in the number of samples undertaken by the two midwifery groups. This is however due to the fact that the less experienced midwives are undertaking fewer tests and in this particular study, we had no control over which midwife we were observing.

Table 4 Midwifery group and time to complete sample, time squeezing and time infant cried

	Experienced midwives, mean (SD)	Less experienced midwives, mean (SD)
Time to complete sample (s), $p < 0.0001$	94.6 (71.3)	218.9 (209.2)
Time squeezing (s), $p = 0.7$	31.3 (55.6)	67.5 (131.9)
Time infant cried (s), $p = 0.2$	39.8 (57.7)	80.35 (149.7)

Step-by-step instructions (e.g. NHS Scotland, 2003) for heel prick sampling are provided on the dried blood spot cards. The empirical evidence behind each of these steps is questionable.

The majority of procedure instructions (Meehan, 1998; Meites, 1988; Moxley, 1989) suggest that the puncture site should be cleaned with an alcohol wipe and either dried with a sterile gauze or left to dry for 30 s. Others suggest that the risk of alcohol contamination in the blood sample should be entirely avoided and that the puncture site should only be cleaned with warm water (Baston, 2002). The United Kingdom Newborn Screening Programme Centre (2004) recommend that the sample be taken from a 'clean' heel and highlight that any sample contaminated with faeces will have unduly high levels of immuno-reactive tripsinogen (measured for cystic fibrosis).

In this study, only 3.8% of babies had their heels cleaned and all were cleaned with alcohol wipes even though NHS Scotland (2003) advises midwives should use soap and water. The reason for cleaning is presumably to prevent infection but infection rates from heel pricks have not been documented and therefore the need to clean the heel has not been fully justified.

A significant difference was noted between midwifery groups and the position of the baby during testing. NHS Scotland (2003) guidelines suggest the mother cuddles the baby on her knee during testing as this supposedly assists the midwife and comforts the baby. This technique was favoured by the less experienced midwives as it allowed them the freedom to organise the equipment necessary without the added pressure of holding the baby. This may also be the reason for more babies in the less experienced midwifery group (24.5%, as opposed to 10.5% in the experienced group) feeding at the time of testing and using mother–infant skin-to-skin contact (less experienced group 20%, experienced group 9.1%).

A number of studies have advocated the analgesic effect of breast feeding during painful procedures (Carbajal et al., 2003; Gray et al., 2002). Carbajal et al. (2003) studied 180 babies undergoing venepuncture and found that breastfeeding during the procedure significantly reduced the infant's apparent pain. Gray et al. (2000) in a small study of 30 infants reported that 10–15 min of skin to skin contact only between mothers and infants reduced crying, grimacing, and heart rate during heel lance procedures. Carbajal et al. (2003)

detected no reduction in response to pain in infants (dressed) who were simply held in their mother's arms.

The only measure of pain recorded in this study was length of time crying. No significant difference was noted between groups. This may be due to the small number of infants either feeding or having skin-to-skin interaction during the procedure.

A significant difference between midwifery groups was noted in both the quality of sample obtained and the number of heel pricks required to obtain the sample. On both counts the experienced midwives appeared more efficient.

Very few studies have considered the experience of the health professional undertaking the test. Spiel (1997) observed seven heel pricks from midwives of different experiences. The less experienced midwife was seen twisting the blade, making a second puncture and vigorously squeezing the infants' heel. Speil (1997) observed that the more experienced midwives appeared more efficient in obtaining a good blood flow, did not twist the blade or make more than one puncture and compared to the less experienced midwives were a lot less forceful in squeezing the infants heel. Although Spiel's study is very limited as such a small number of heel prick procedures were observed, it is interesting to note that, as in our study, the experienced midwives were more successful in obtaining a good quality sample without the need for more than one puncture.

Although no significant differences were noted in the present study, it is interesting to observe that the experienced midwives did squeeze the heel as often as the less experienced but not for as long. This may have important consequences as others have noted that excessive squeezing of the heel is the most painful part of the heel prick procedure (Baston, 2002; Lindh et al., 1999).

The question is of course, what exactly is it that the experienced midwives do to ensure they collect a sample in the most efficient manner possible. From our previously published study (Shepherd et al., 2006), it is clear that the device used by the midwife plays a major role. However, the differences noted in technique and outcome between experienced and less experienced midwives should not be ignored. Our research would tend to indicate that the position of the baby during testing is important. Also, it appears that the experienced midwives paid less attention to the 'pain relieving' measures such as cuddling and use of soothing words but were more 'skilled' in the procedure. This may suggest that the experienced midwives approach the infant in a more confident manner and the infant remains relaxed, whereas the infant displays discreet responses to the action of the more tentative midwife. More research is obviously required to fully investigate this further.

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