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The reliability of foetal blood sampling as a test of foetal acidosis in labour

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ABSTRACT

Objectives: To establish whether foetal blood sampling for pH is a reliable test of foetal acidosis in labour by comparing paired foetal blood samples taken at a single procedure.
Study design: We conducted a prospective study assessing 293 consecutive attempts at foetal blood sampling in labour over a four month period from February to May 2012. A total of 100 paired samples were suitable for analysis. We compared the consistency of pH results of paired foetal blood samples, evaluated cases where inconsistent results would result in conflicting clinical decisions, and explored factors associated with discordant results.
Results: There was a statistically significant difference between the mean pH of the two samples: 7.297 (SD 0.065) versus 7.315 (SD 0.059), $p < 0.0005$. Of the 100 paired samples, 43 had a difference greater than the laboratory acceptable maximum analytical difference of 0.038. There was discordance between the samples in 16 cases with results crossing a decision threshold, and in 11 cases (69%) delivery was by emergency caesarean section. Inconsistent results were not associated with specific clinical factors and occurred more often with senior operators.
Conclusion: Foetal blood sampling is considered by many as the gold standard in assessing intrapartum foetal wellbeing. We have demonstrated inconsistency of paired foetal blood pH results which suggests that foetal blood sampling should not be considered infallible.

1. Introduction

The assessment of foetal wellbeing in labour is an issue of great importance to pregnant women and to health professionals providing their care. Cardiotocography, foetal blood sampling for pH, foetal scalp lactate, foetal pulse oximetry and foetal electrocardiography in labour have all been proposed as monitoring tools to improve perinatal outcomes, with varying degrees of success [1–5]. Cardiotocography in particular has been disappointing, as there is inter- and intra-observer variability, even among experts, and a high rate of false positive recordings resulting in an increase in potentially unnecessary emergency caesarean sections [1–3,6].

In 1963, Bretscher and Saling established the technique of foetal scalp pH analysis as a diagnostic tool to detect foetal acidosis in labour and consequently to assess intrapartum foetal wellbeing or compromise [7]. In the event of foetal hypoxia, anaerobic metabolism results in a state of metabolic acidosis; pO_2 decreases, pCO_2 increases and pH falls due to the build-up of H+ ions [8]. A normal pH result allows labour to continue, a borderline result needs to be repeated after a 30 min interval, and an abnormal result requires delivery [1]. The aim is to deliver when there is objective evidence of intrapartum foetal compromise but well before the foetus sustains irreversible brain damage. An abnormal pH is classified as less that 7.20 and has a higher specificity than a pathological CTG in predicting a low Apgar score at 1 min [9]. When accompanied by interpretation of intrapartum cardiotocography, foetal blood sampling results in a decrease in the number of caesarean sections, instrumental deliveries and episiotomies. A decrease in emergency caesarean sections for 'foetal distress' has not, however, been demonstrated, which may reflect underpowering of the studies published to date [3].

Foetal blood sampling is an invasive procedure, whereby a few drops of foetal capillary blood are collected in heparinised tubes following a small scalp puncture with a blade. It can be an uncomfortable test for both the patient and the operator and takes on average 17 to 18 min to get a result [10,11]. Foetal blood sampling is considered by many as the gold standard in assessing foetal wellbeing in labour and forms an important part of intrapartum decision-making. The reliability of foetal blood sampling as a test of foetal acidosis in labour has received little attention to date [12]. The hypothesis for this study is that inconsistency of paired foetal blood pH results and discordance of resultant management decisions may be demonstrated in some

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cases and that foetal blood sampling should not be considered infallible.

2. Materials and methods

This was a prospective study assessing consecutive attempts at foetal blood sampling over a period of four months from February to May 2012. The study continued until at least 100 paired samples were available for analysis. The study was limited to women with a singleton pregnancy, cephalic presentation, gestational age greater than 36 completed weeks, and with a clinical indication for foetal blood sampling. The criteria for use of electronic foetal monitoring, the procedures for interpretation and classification of cardiotocography and the indications for foetal blood sampling were in keeping with the Intrapartum Care Guideline of the National Institute of Health and Clinical Excellence [1]. Once the decision to perform a foetal blood sample was taken, operators were asked to collect two foetal capillary blood samples from a single scalp puncture in heparinised tubes and each sample was analysed using a blood gas analyser (Chiron 248) located on the labour ward. The analyser has a clot catcher and alerts for air bubbles or a short sample. The blood gas analyser self-calibrates routinely every four hours with additional quality control checks performed by the laboratory staff using test solutions mimicking acidemic, normal and alkalotic samples.

The staff on the labour ward had been informed of the purpose of the study and the researcher recorded details relating to the stage of labour, position of the patient, grade of operator, analgesia, number of samples obtained, time interval between results of paired samples, pH results at sampling, management decision, mode of delivery, neonatal outcome and cord blood arterial and venous pH results at delivery. The information was recorded in a specially designed proforma. The decision to perform the foetal blood sample was made by the clinician caring for the patient and each clinician obtained consent from the woman for the procedure. As this was an observational study, including routinely collected data, individual patient consent was not considered necessary for data analysis. Approval from the Research Ethics Committee of the hospital was granted for the study (Study No. 28 – 16 December 2011).

2.1. Statistical analysis

Summary statistics for the pH of sample 1 and sample 2 are presented as means and standard deviation (SD) and a paired *t*-test was performed to test for a significant difference between the two groups. The management decisions for each pH result were classified as follows: (i) continue current management (pH $>$ 7.25), (ii) repeat foetal blood sample in 30 min (pH 7.20–7.25) and (iii) deliver (pH $<$ 7.20) [1]. The cases with a discrepancy between sample 1 and sample 2 that fell on different sides of clinical decision-making thresholds were quantified and described in more detail, (e.g. pH $<$ 7.20 warrants delivery and therefore results of 7.19 and 7.21 would be classified as inconsistent). The cohort was divided into cases with concordant and discordant clinical decision-making results. The response to discordant results was determined by the lead clinician and included the options of either repeating the foetal blood sample immediately, repeating the sample after thirty minutes, or proceeding to immediate delivery. Factors associated with discordant clinical decision-making results are presented as odds ratios with 95% confidence intervals. The statistical package SPSS was used for data analysis.

3. Results

During the four month study period there were 293 consecutive foetal blood sampling procedures. Of the 293 procedures, 100 paired samples were successfully analysed, 174 resulted in a single sample with no attempt to analyse a second sample, and there were 19 cases where it was not possible to take a second sample although this had been attempted. There were no cases where it was not possible to achieve at least one sample. The mean pH for the sample with the lower reading (''sample 1'') was 7.297 (SD 0.065) compared to the mean pH for the paired sample (''sample 2'') of 7.315 (SD 0.059), mean difference 0.036 ($p < 0.0005$). The mean time interval between reporting the two pH results was 2.47 min (range 1–12 min).

The laboratory acceptable maximum analytical difference was calculated at 0.038 (4 standard deviations of the mean for tests assays performed by the laboratory staff on the labour ward machine). Of the 100 paired samples, 43 had a difference greater than 0.038. The management decision based on the pH result of sample 1 was to continue labour in 78 cases, repeat the procedure in 30 min in 14 cases and to deliver in 8 cases. The management decision based on the pH result of sample 2 was to continue labour in 89 cases, repeat the procedure in 30 min in 8 cases and to deliver in 3 cases. There was discordance in the management decision between the two groups in 16 cases (Table 1). In 11 of the 16 cases (69%) this resulted in a decision to deliver by emergency caesarean section. In two cases (7 and 15) the foetal blood sample pH results

Table 1
Cases of discordant foetal blood samples.

Case Number	Lower pH result	Higher pH result	Decision	Mode of delivery	Apgar scores at 1,5 min	Cord blood pH artery	Cord blood pH vein	Neonatal outcome
1	7.193	7.202	Deliver	Ventouse	8, 10	7.293	7.298	Normal
2	7.131	7.220	Deliver	LSCS	9, 10	7.165	7.169	Normal
3	7.197	7.228	Deliver	Forceps	9, 9	7.179	7.293	Normal
4	7.142	7.235	Deliver	LSCS	9, 10	7.208	7.260	Normal
5	7.192	7.246	Deliver	LSCS	9, 10	7.314	7.357	Normal
6	7.235	7.254	Deliver	LSCS	9, 10	7.301	7.382	Normal
7	7.239	7.259	Repeat	LSCS	3, 6	7.254	7.271	Neonatal unit Admission
8	7.227	7.265	Deliver	LSCS	9, 10	7.254	7.360	Normal
9	7.245	7.269	Repeat	Ventouse	7, 9	7.290	7.340	Normal
10	7.238	7.269	Repeat	LSCS	9, 10	7.284	7.336	Normal
11	7.239	7.270	Repeat	LSCS	9, 10	7.246	7.290	Normal
12	7.204	7.275	Continue	Ventouse	9, 10	7.183	7.295	Normal
13	7.230	7.275	Deliver	LSCS	9, 10	7.186	7.268	Normal
14	7.232	7.282	Deliver	LSCS	9, 10	7.297	7.339	Normal
15	7.237	7.284	Repeat	Ventouse	6, 7	7.217	7.295	Neonatal unit Admission
16	7.201	7.289	Continue	LSCS	9, 10	7.287	7.342	Normal