

Does training in obstetric emergencies improve neonatal outcome?

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Objectives To determine whether the introduction of Obstetrics Emergency Training in line with the recommendations of the Clinical Negligence Scheme for Trusts (CNST) was associated with a reduction in perinatal asphyxia and neonatal hypoxic–ischaemic encephalopathy (HIE).

Design A retrospective cohort observational study.

Setting A tertiary referral maternity unit in a teaching hospital.

Population Term, cephalic presenting, singleton infants born at Southmead Hospital between 1998 and 2003 were identified; those born by elective Caesarean sections were excluded.

Method Five-minute Apgar scores were reviewed. Infants that developed HIE were prospectively identified throughout this period. The study compared the period 'pre-training' (1998–1999), with the period 'post-training' (2001–2003).

Main outcome measures Five-minute Apgar scores and HIE.

Results Infants (19,460) were included. Infants born with 5-minute Apgar scores of ≤ 6 decreased from 86.6 to 44.6 per 10,000 births ($P < 0.001$) and those with HIE decreased from 27.3 to 13.6 per 10,000 births ($P = 0.032$) following the introduction of the training courses in 2000. Antepartum and intrapartum stillbirth at term rates remained unchanged, at about 15 and 4 per 10,000 births, respectively.

Conclusion The introduction of obstetric emergencies training courses was associated with a significant reduction in low 5-minute Apgar scores and HIE. This improvement has been sustained as the training has continued. This is the first time an educational intervention has been shown to be associated with a clinically important, and sustained, improvement in perinatal outcome.

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Introduction

One of the most important objectives of the care of women in labour is the recognition of fetal compromise followed by appropriate delivery of the infant avoiding stillbirth, asphyxia, brain damage and consequent disability.

In an audit of intrapartum-related stillbirths in the United Kingdom (UK),¹ more than 75% had evidence of suboptimal care such that alternative management 'might, or would reasonably be expected to, have made a difference to the outcome'. The most frequent criticisms related to failures in the use and interpretation of cardiotocograph (CTG) tracings.

Where there has been a delay in recognition of fetal compromise and/or inappropriate action taken, the more severely

affected infants remain physiologically depressed for more than 5 minutes, require prolonged resuscitation and may develop hypoxic–ischaemic encephalopathy (HIE).² Moderate and severe grades of HIE have a high risk of subsequent cerebral palsy and cognitive disability. Medico-legal claims for cerebral palsy arising from negligent intrapartum care now make up the majority of the National Health Service (NHS) annual litigation bill.³

The Department of Health in the United Kingdom has targeted a 25% reduction in the incidence of negligent harm in obstetrics, by 2005, as one of its primary objectives.⁴ This follows a number of recommendations by national bodies to improve standards of obstetric care using multidisciplinary approaches to training.^{1,5,6} The British Clinical Negligence

Scheme for Trusts (CNST) has proposed a core content for training courses including evidence of six monthly CTG training for all clinical staff.⁷ However, there is no clear guidance as to the best method of training or, indeed, even any evidence to suggest that training improves outcome. A recent systematic review of worldwide literature on training programmes in obstetric emergencies concluded that few training programmes have been described, and even fewer evaluated.⁸

The purpose of this study was to determine whether the introduction of this type of training improved neonatal outcome as measured by reductions in the number of infants born with a 5-minute Apgar score of 6 or less, and the number of infants with HIE.

Method

This was a retrospective cohort study of babies born during the period between 1st January 1998 and 31st December 2003. The main outcomes were the rates of 5-minute Apgar score ≤ 6 , and neonatal hypoxic–ischaemic encephalopathy. The study was approved by the Southmead Hospital Local Research Ethics Committee.

In 2000, a multi-professional group comprising midwives, obstetricians and anaesthetists at Southmead hospital in Bristol developed a training course. This is a one-day training course that is held bi-monthly to accommodate all midwifery staff, including managerial, community-based and part-time midwives, and all obstetric medical staff, including senior house officers (SHOs), specialist registrars (SpRs) and consultants. Annual attendance is mandatory and is recorded on a database maintained by the risk manager's secretary. New members of staff are required to attend the next available course, and an end of year course is run for those who failed to attend their planned course.

The course consists of a morning session for CTG Interpretation, which uses a variety of teaching techniques: pre-reading workbook with cases to be completed prior to the course, lectures based on the National Institute for Clinical Excellence (NICE) Electronic Fetal Monitoring (EFM) guidelines, small group case discussions and also a session on documentation including the use of a structured reporting proforma. This proforma in the form of a sticker requires the practitioner to classify and document four CTG features: baseline fetal heart rate, variability, presence or absence of accelerations and types of decelerations, if present. The user is then required to provide a course of action based on the clinical circumstances.

In the afternoon, participants attend six obstetric emergency drill stations, which include training in the management of the following: shoulder dystocia, postpartum haemorrhage, eclampsia, twins, breech, adult resuscitation (including cardiopulmonary resuscitation) and neonatal resuscitation.

All of the course materials were developed 'in house' by the multi-professional steering group. The course utilises a faculty of 10 people with the use of additional midwifery and medical staff.

There is no course fee for participants and the venue is provided free of charge by the hospital. All midwives on a permanent contract are allocated two days study leave per annum to attend mandatory in-house training. The direct costs for the course are for printing the pre-reading booklets etc. (UK£2500 per annum). These additional costs are covered by the departmental budget. All medical staff use one of their allocated study days.

Using a standard UK-based maternity database, STORK, we identified all infants born during the six-year period from 1st January 1998 to 31st December 2003 for inclusion in the study.

Infants born outside Southmead Hospital and those delivered by elective caesarean section were excluded. We also excluded multiple pregnancies known prior to, or discovered in labour. As Apgar scores are significantly affected by gestation,⁹ we excluded all preterm infants (gestation < 37 weeks) from the study. The management of pregnancies where there was a breech presentation changed significantly during the study period¹⁰ and we have therefore excluded all of these infants, whether they laboured or not. The exclusions are detailed in Fig. 1.

We chose to classify, as one of the measures of poor neonatal outcome, an Apgar score of 6 or less at 5 minutes as per the Cerebral Palsy Template.¹⁰ All infants born at this hospital are routinely assigned an Apgar score⁹ at 1 and 5 minutes of age, by one of the attendants present at the birth either a midwife, or neonatal medical staff.

Infants born at Southmead Hospital that subsequently developed neonatal encephalopathy were prospectively identified from 1st January 1998 to 31st December 2003 using inclusion criteria based on Adamson *et al.*¹¹

Prospective identification was possible as from the beginning of 1998 infants were being enrolled in trials of hypothermia as treatment for HIE. The diagnostic criteria for neonatal encephalopathy were disturbed neurological function starting within the first 72 hours after birth and included any combination of the following: decreased responsiveness, marked changes in tone, activity, reflexes, absent sucking, depressed respiration, abnormal movements or clinical seizures.

We excluded neonates with neuromuscular conditions and congenital abnormalities of the central nervous system (CNS). Cases of neonatal encephalopathy were identified prospectively in order to be sure of including all infants later categorised as being hypoxic–ischaemic. Those with possible encephalopathy were neurologically assessed and amplitude-integrated electroencephalography (aEEG) recorded using a Cerebral Function Monitor (Lectromed, Letchworth, UK).

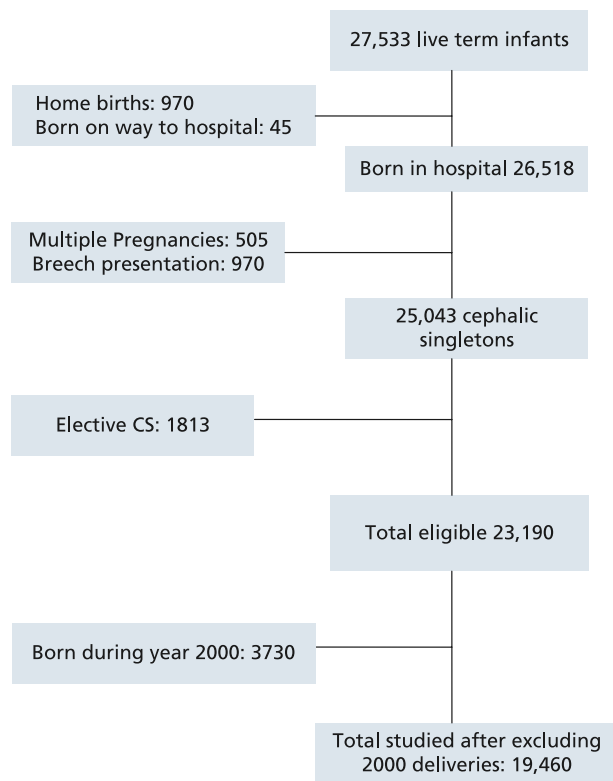


Figure 1. Flow chart showing women studied and reasons for exclusion.

In addition to the prospective ascertainment of cases, a retrospective search for encephalopathy was carried out using the discharge summaries from the neonatal unit, the neonatal database and admission book, and the hospital coding department using the *International Classification of Diseases* (ICD) 10th edition diagnostic codes P21.0, P21.1, P21.9, P90, P91.0, P91.3, P91.4, P91.5 and P91.9.¹² Each possible case was then fully evaluated using the medical and nursing notes to see if the infant really fulfilled the above criteria for encephalopathy and HIE. The severity of HIE was graded according to the criteria of Sarnat and Sarnat,¹³ modified to utilise aEEG criteria instead of full EEG.^{14,15}

Biochemical, haematological and microbiological testing was performed to exclude other causes of encephalopathy. Cranial ultrasound examinations were carried out and repeated as necessary to follow the evolution of any lesions seen. Infants with moderate or severe encephalopathy were also examined using magnetic resonance imaging (MRI),¹⁶ with the CT scanner being used during the first three months of the study period while arrangements for MRI were organised.

When classifying encephalopathy as HIE, criteria based on MacLennan¹⁷ were used: metabolic acidosis in intrapartum fetal, umbilical arterial cord or very early neonatal blood samples (pH < 7.00 or base deficit 12 mmol/l) together with one or more of the following: a sentinel (signal) hypoxic event occurring immediately before or during labour; a sudden,

rapid and sustained deterioration of the fetal heart rate pattern; Apgar scores of 0–6 for longer than 5 minutes; early evidence of multi-system involvement; and/or early imaging evidence of acute cerebral abnormality. For the purposes of this study; mild HIE was characterised by hyperalertness, behavioural change and reflex change without seizures. Moderate HIE was characterised by markedly abnormal tone, reduced responsiveness and (often) seizures with a discontinuous or slightly reduced amplitude EEG. Severe HIE was characterised by unresponsiveness, loss of basic reflexes, (often) ventilator dependence and EEG showing very low amplitude or burst suppression. Moderate and severe HIE also required early imaging consistent with an acute event with no evidence of long standing fetal brain injury or congenital abnormality.¹¹

Statistical analyses were done using STATA version 8.0 software (StataCorp, Texas, USA).

In order to assess the impact that the course may have had, we divided the study period into two: 1st January 1998 to 31st December 1999 (pre-training) and 1st January 2001 to 31st December 2003 (post-training). The training course was introduced in 2000 and therefore all babies born during the year 2000 were excluded from the main analysis.

We compared the incidence rates of Apgar scores ≤ 6 , and those of HIE, between these two study periods. The χ^2 testing is used for comparisons of proportions. Results are reported in proportions (%) and relative risks, with 95% confidence intervals and *P* values where appropriate.

Results

There were 27,533 live term infants born at Southmead Hospital during the period January 1998 to December 2003; 23,190 of them satisfied the study entry criteria. For the main analyses, we excluded all those babies born in 2000, leaving a total of 19,460 babies. During the same period studied, there were 36 term infants that were stillborn, with the intrauterine death (IUD) occurring either before or during labour. These were excluded from the main analysis relating to Apgar scores and HIE and are reported separately. Figure 1 illustrates the patient flow and exclusions.

Table 1 summarises the baseline characteristics of the two comparison groups, 1998–1999 and 2001–2003. In the second period of the study (2001–2003), there was a higher proportion of women who were older and nulliparous. They were also more likely to have had their labour induced and to have had an emergency caesarean section. The groups were similar in gestational age at delivery, and infant birthweight.

Among the group of infants studied, we found statistically significant reductions in the rates of both the 5-minute Apgar ≤ 6 and HIE (Table 2). There was a downward trend in moderate and severe HIE but this did not reach statistical significances.

Table 1. Baseline characteristics and mode of delivery

	1998–1999 Pre-training	2001–2003 Post-training
Maternal age (mean, SD)	28.8 (5.3)	29.2 (5.7)*
Gestational age (median, range)	40 (37–44)	40 (37–44)
Parity (n, %)		
Nullipara	3278 (43.6%)	4772 (46.2%)*
Multipara	4247 (56.4%)	5560 (53.8%)*
Labour onset (n, %)		
Spontaneous onset	6370 (76.4%)	8161 (74.8%)
Induced labour	1967 (23.6%)	2743 (25.2%)
Mode of delivery (n, %)		
Vaginal (including operative)	7646 (90.7%)	9776 (88.6%)*
Emergency CS	784 (9.3%)	1254 (11.4%)*
Birthweight, g (mean, SD)	3461.6 (487.1)	3457.5 (489.5)

* $P < 0.001$.

In Table 3, we have also included low Apgar scores incidence rates for 1996 and 1997. This shows that, prior to 2000, the low Apgar score incidence fluctuated between 73.4 and 90.4 without any clear rising or falling trend. There was quite a steep drop occurring during 2000–2001, and the rates stayed low throughout the subsequent years. Prospective HIE data for 1996 and 1997 were not available for analysis.

We found no change in the rates of both intrapartum and antepartum IUDs among the group we studied. In 1998–1999, there were 13 antepartum stillbirths (15.4 per 10,000 deliveries) and 3 intrapartum stillbirths (3.6 per 10,000 deliveries). In 2001–2003, there were 16 antepartum stillbirths (14.8 per 10,000 deliveries) and 4 intrapartum stillbirths (3.6 per 10,000 deliveries).

All antepartum stillbirths were confirmed to have occurred before the mothers presented to hospital.

Discussion

Our main findings were a significant reduction in the incidence of infants born with a 5-minute Apgar score of 6 or less,

and HIE, following the introduction of the obstetric emergencies training course. This improvement was sustained over time. Only moderate and severe grades of HIE are predictive of cerebral palsy and are relatively rare, occurring in 1–2 per 1000 births.² It is thus difficult to achieve sufficient statistical power with this important clinical outcome. Our data show a downward trend in moderate and severe HIE which is broadly in line with the reduction in HIE (all grades) and low 5-minute Apgar score.

During the two years immediately prior to the introduction of this training course, (1998 and 1999), there appears to have been a pre-existing downward trend in adverse neonatal outcomes. However, on further investigation we found that the low 5-minute Apgar score occurred in 73.4 per 10,000 in 1996 and in 81.9 per 10,000 in 1997. Consequently, although there does appear to have been a peak in poor outcomes in 1998, there was no pre-existing trend towards improvement, or indeed worsening of neonatal outcomes (Fig. 2). The 5-year average rate of low Apgar scores was above 80 per 10,000 births before the introduction of this training course, and has been reduced to fewer than 45 per 10,000 births. We do not have HIE data for 1996 and 1997 but for all of the years that we have studied, the improvements in HIE rates appear to have paralleled those of low Apgar scores.

There were demographic differences in the period of the study with a higher proportion of the women being older, nulliparous and also having their labour induced. Both induction of labour and nulliparity are known to be associated with increased risks of delivery by emergency caesarean section, and an increased incidence of poor neonatal outcome.^{18,19} Despite this, there was still a significant improvement in neonatal outcomes following the introduction of the training programme.

One other apparent difference between the two study periods was an increase in the emergency caesarean section rate in the second period (9.3% vs 11.4%, $P < 0.001$, χ^2 test). This could be explained by the increased incidence of nulliparity and induction of labour but might also suggest that there was a better recognition of intrapartum problems as a result of the training, with appropriate intervention by pre-emptive delivery. However, we are unable to verify these assertions due to lack of data.

Table 2. Apgar score and HIE before (1998–1999) and after (2001–2003) introduction of training in obstetric emergencies

	1998–1999 (<i>n</i> = 8430)	2001–2003 (<i>n</i> = 11,030)	Relative risk
5-minute Apgar \leq 6, <i>n</i> (rate per 10,000)	73 (86.6)	49 (44.4)	0.51 (0.35–0.74)
HIE, <i>n</i> (rate per 10,000)	23 (27.3)	15 (13.6)	0.50 (0.26–0.95)
Moderate/severe HIE, <i>n</i> (rate per 10,000)	16 (19.0)	11 (10.0)	0.53 (0.24–1.13)

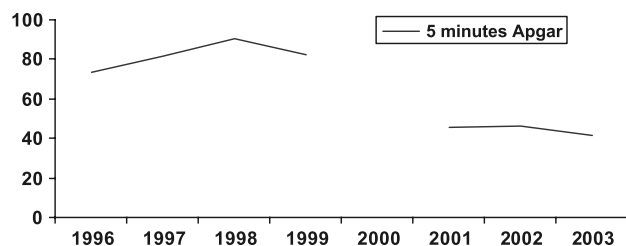
Table 3. Apgar score and HIE (graded) for each year

Year	1996	1997	1998	1999	2000	2001	2002	2003
Low 5-minute Apgar, <i>n</i> (rate per 10,000)	34 (73.4)	37 (81.9)	40 (90.4)	33 (82.4)	26 (69.7)	16 (45.4)	17 (46.5)	16 (41.5)
HIE all grades, <i>n</i> (rate per 10,000)	N/A	N/A	13 (29.4)	10 (25.0)	8 (21.5)	5 (14.2)	5 (13.7)	5 (13.0)
Moderate/severe HIE, <i>n</i> (rate per 10,000)	N/A	N/A	7 (15.8)	9 (22.5)	3 (8.0)	4 (11.4)	2 (5.5)	5 (13.0)

In an observational study, it is difficult to know what has led to the changes that we have identified. The training course was introduced in order to improve clinical outcomes including neonatal outcomes and the objective of this study was to investigate whether improvements have taken place. Our results suggest that there has been an improvement, which coincided with the year of introduction of this course, suggesting there is an association between the two.

This is the first time that an educational intervention (training course) has been shown to be associated with a direct improvement in neonatal outcome, and while it would be rewarding to link this directly to the training course, there may be other reasons to explain this improvement. The NICE EFM Guideline was introduced in 2001. It was widely publicised and contained a practical wall chart algorithm. However, its introduction post-dates the introduction of our programme and cannot itself account for the improvements in outcomes seen. A second confounder is that the course was designed to fulfil all the requirements for CNST, which was achieved in 2003. The multiple clinical governance interventions and organisational changes associated with the totality of that programme could have played a role in improving outcomes.

Other examples of local training programmes have been reported, but none have led to objective clinical improvement. In a 5-year programme of clinical governance using guidelines, cyclical audit, monthly feedback meetings and training sessions in CTG, Young *et al.*²⁰ demonstrated an improvement in cases of suboptimal care but the proportion of infants with Apgar scores of 6 or less, low cord pH or Neonatal Intensive Care Unit (NICU) admissions did not change. This lack of improvement in any of their observed clinical outcomes might be explained by differences in

**Figure 2.** Graph demonstrating the number of low Apgar's pre- and post-training.

approach and content. Young's group invited all staff involved in intrapartum care to take part, but only a minority of medical staff participated, and it is unclear what proportion of midwives attended. At Southmead, annual attendance is mandatory for all midwifery and medical staff; over 99% had attended in the first year. Unlike the North Staffordshire programme, the Southmead training course also includes emergency drill training.

A number of national teaching programmes such as *Managing Obstetric Emergencies & Trauma* (MOET)^{21,22} and *Advanced Life Support in Obstetrics* (ALSO)^{21,22} have demonstrated an improvement in the confidence of staff after training. None have demonstrated whether this has been translated into improvement in clinical outcomes. This may be because it is difficult to train all, or a critical mass of staff within a unit, if they have to attend distant courses.

Black and Brocklehurst in their review of obstetric emergencies training note the potential advantages of local training courses; they may reduce cost and increase access to training.⁸ This course is based within the hospital giving easier access for staff to attend and, as stated previously, more than 99% of all midwifery and medical staff had attended by the end of the first year of the course. Although difficult to quantify, we believe that the multi-professional involvement, almost full participation of staff and the use of local 'experts' in the delivery of this comprehensive training course have all been key factors in its success.

In conclusion, the findings of this study are important because they provide evidence that specific multi-professional training in obstetric emergencies using local in-house courses, as suggested by the CNST, are practical and may improve neonatal outcome.

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