

# Change in knowledge of midwives and obstetricians following obstetric emergency training: a randomised controlled trial of local hospital, simulation centre and teamwork training

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**Objectives** To explore the effect of obstetric emergency training on knowledge. Furthermore, to assess if acquisition of knowledge is influenced by the training setting or teamwork training.

**Design** A prospective randomised controlled trial.

**Setting** Training was completed in six hospitals in the South West of England, UK and at the Bristol Medical Simulation Centre, UK.

**Population** Midwives and obstetric doctors working for the participating hospitals were eligible for inclusion in the study. A total of 140 participants (22 junior and 23 senior doctors, 47 junior and 48 senior midwives) were studied.

**Methods** Participants were randomised to one of four obstetric emergency training interventions: (1) 1-day course at local hospital, (2) 1-day course at simulation centre, (3) 2-day course with teamwork training at local hospital and (4) 2-day course with teamwork training at simulation centre.

**Main outcome measures** Change in knowledge was assessed by a 185 question Multiple-Choice Questionnaire (MCQ)

completed up to 3 weeks before and 3 weeks after the training intervention.

**Results** There was a significant increase in knowledge following training; mean MCQ score increased by 20.6 points (95% CI 18.1–23.1,  $P < 0.001$ ). Overall, 123/133 (92.5%) participants increased their MCQ score. There was no significant effect on the MCQ score of either the location of training (two-way analysis of variants  $P = 0.785$ ) or the inclusion of teamwork training ( $P = 0.965$ ).

**Conclusions** Practical, multiprofessional, obstetric emergency training increased midwives' and doctors' knowledge of obstetric emergency management. Furthermore, neither the location of training, in a simulation centre or in local hospitals, nor the inclusion of teamwork training made any significant difference to the acquisition of knowledge in obstetric emergencies.

**Keywords** Knowledge, obstetric emergencies, simulation, teamwork, training.

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## Introduction

The Confidential Enquiries into Maternal Deaths<sup>1–3</sup> and the Confidential Enquiries into Stillbirths and Deaths in Infancy<sup>4,5</sup> have repeatedly identified substandard care in a significant proportion of maternal, fetal and neonatal deaths in the UK.

In the UK, obstetric emergency training is conducted nationally, for example, Advanced Life Support in Obstetrics (ALSO) and Managing Obstetric Emergencies and Trauma (MOET), as well as locally within maternity units.<sup>6</sup> Training

courses aim to improve participants' performance in the three domains of learning; knowledge, skills and attitudes.<sup>7</sup> So far, there has been no objective evaluation of the effect of obstetric emergency training on any of these learning domains; it is acknowledged that further research on the benefits of such training is required.<sup>6</sup>

The objectives of this paper were to explore the effect of multiprofessional obstetric emergency training on knowledge, as indicated by Multiple-Choice Questionnaire (MCQ) scores, and to investigate whether changes in knowledge were

influenced by teamwork training or by the location of training (local hospital versus simulation centre training).

## Methods

This was a prospective randomised controlled trial, as part of the wider Simulation and Fire-drill Evaluation (SaFE) study. Participant staff were recruited from six District General Hospitals in the South West of England, UK. The delivery rates ranged from 2500 to 4600 per annum. Recruitment took place from September to November 2004 in three hospitals and from December 2004 to February 2005 in the remaining three hospitals.

All midwives (including those working in hospital or the community) and all doctors, working within the Obstetric Department (including general practice trainees, obstetric and gynaecology trainees and consultants) of the six participating hospitals were eligible for inclusion in the study. Staff were not eligible for randomisation to the study if any of the following criteria were present: (1) participation at a nationally accredited obstetric emergency management course within the 12 months prior to randomisation, (2) already booked to attend an accredited training course within the duration of the study, (3) participation in the pilot phase of the study, (4) involvement in the delivery of the training interventions or evaluations, (5) if on maternity or long-term sick leave and (6) consultants working solely in gynaecology with no emergency obstetric commitments.

Participants (staff to be trained) were randomised to one of four training interventions (Figure 1). The description of the different training interventions is summarised in Table 1.

The clinical content of both the 1- and 2-day training interventions (courses) was identical regardless of the locality. Lectures were given using standardised PowerPoint presentations and lecture notes. Simulated clinical emergency scenarios, 'fire-drills', followed the same outline in the local and simulation centre courses; however, the training equipment used at the simulation centre was more sophisticated, using computer-controlled mannequins that respond to treatment, than that used in the local courses. 'Fire-drills' were conducted on the delivery suite in each local hospital or in a simulated clinical environment at the simulation centre. All participants received a course manual; the manual for the 2-day course included an additional chapter on team working.

To limit the variation in the content and delivery of teaching, all trainers in the study attended a 'Training the Trainers Day' and received a Trainers' package, which included a Trainer's manual, teaching presentations and training aids. The study's education coordinator ran a telephone helpline to assist trainers in the implementation of the course in their local hospital.

Pretraining assessment in the form of a MCQ was undertaken 1–3 weeks prior to the training intervention. Post-training assessment was undertaken 1–3 weeks after the training intervention using the same bank of MCQ questions but in a different order. The variations in time intervals for the assessments were due to pre-existing factors, including other local courses, school holidays and availability of the simulation centre. All participants were given 45 minutes to complete the 185 questions, negatively marked, true/false/don't know MCQs under exam conditions. Questions related to the incidence, risk factors, emergency management and drug treatment of the following obstetric emergencies: basic life support, advanced life support, hypertensive disorders of pregnancy, shoulder dystocia, breech, twins, cord prolapse, postpartum haemorrhage and electronic fetal monitoring. The MCQ was produced by an expert panel of midwives and obstetricians and had been adapted from a validated 240 question MCQ bank used during the pilot phase of the study. Following the pilot, questions that were poorly discriminating were removed.

No feedback on scores or answers was given to participants or trainers either before or after training. The MCQs were marked by a computerised optical mark reader system with a reported scanning error rate of less than one per million marks scanned (Multiquest for Windows, Speedwell Computer Services). Any question response identified as unrecognisable by the Multiquest system was reviewed and independently marked by two study evaluators, who had undergone training in the Multiquest system. Results were exported from the Multiquest system to an Excel spreadsheet.

We estimated that a sample size of 36 per intervention should give 89% power to detect a difference of 20 in the mean postintervention MCQ scores associated with either the simulation centre training or with team training (estimated within-group SD = 35).



**Figure 1.** Training interventions (obstetric emergency training).

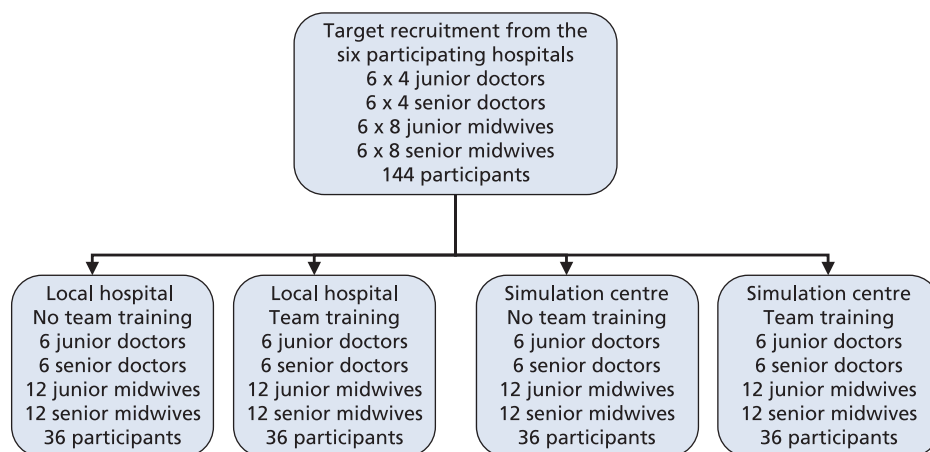
**Table 1.** Description of training interventions

	Local hospital course	Simulation centre course
Trainers	Local obstetricians, midwives and anaesthetists	Obstetricians, midwives and anaesthetists from the South West region of the UK
Mannequins	Locally available low-fidelity mannequins and training aids	Computer-controlled high-fidelity mannequins, which respond to treatment
Location	Local hospital	Simulation centre—a distance of 5–170 miles from local hospitals
Content	Identical	Identical
Course manual	Identical	Identical
Training drills	Conducted in a local delivery suite room	Conducted within a simulated clinical environment
Participants	Six participants in each local hospital per course	Eighteen participants; three teams of six from three hospitals per course
Cost of training venue	Free of charge	£1500 per day
	No teamwork training course	Teamwork training course
Content	Clinical	Clinical plus teamwork training
Length	1 day	2 days
Course manual	No teamwork chapter	Teamwork chapter
Participants per course	One team of six or three teams of six dependant on course location	One team of six or three teams of six dependant on course location

The target recruitment was 144 participants, 36 per intervention, to be recruited from six hospitals. The target recruitment (Figure 2) comprised four junior and four senior doctors, and eight junior and eight senior midwives from each of the six hospitals; each training intervention to comprise a team containing one junior and one senior doctor, and two junior and two senior midwives from each hospital. Participants were first stratified by hospital followed by staff type and years of experience (midwives  $\leq 5$  years and  $> 5$  years; doctors  $\leq 3$  years and  $> 3$  years) within each hospital. The four lists of staff for each hospital were

each randomly reordered, using a computer-generated randomisation sequence, by the study's regional coordinator. An allocated local study coordinator was then responsible for recruiting staff to the study. Staff were selected from the top of each list in each of the six hospitals. After obtaining consent from a participant, the local study coordinator telephoned the regional coordinator who randomly allocated the participant to the next training intervention from a pre-determined list.

Ethical approval was granted from a Regional Research Ethics Committee (04/Q2103/68) and site-specific ethical

**Figure 2.** Target recruitment.

approval was granted by the five appropriate local Research Ethics Committees. Research and Development approval was granted by all the Healthcare Trusts involved in the study.

Two-way analysis of variants (ANOVA) (with factors locality and teamwork training) were used to assess the effects of the interventions on the post-training mean scores with subsequent adjustment for the stratifying variable staff group and the pretraining scores. Statistical programs used were Stata vs 8 (StataCorp, College Station, TX, USA, 2003) and 'Proc Mixed' in SAS Release 8.2 (SAS Institute Inc., Cary, NC, USA, 2002).

## Results

At the commencement of the study, a total of 975 staff were working within the maternity departments in the six participating hospitals, of whom 912 were eligible for inclusion and randomised. From the 24 stratified and randomised lists of eligible staff, the first 240 were approached, with 158 giving consent to participate in the study. Eighteen staff subsequently withdrew from the study prior to the first evaluation (Figure 3). The target had been to recruit 144 staff, this was not achieved; two junior doctors and one senior doctor were unable to be recruited due to clinical commitments. In addition, one potential participant withdrew on the morning of the assessment due to illness. One hundred and forty staff therefore entered the study.

Of the 140 participants who entered the study, 136 attended training and 133 completed the post-training assessment (Figure 4); a dropout rate of 7/140 (5%). All dropouts during the study were due to illness. Subsequent analysis is based on these 133 participants (Figure 4).

In total, participants answered 50 222 of the 50 505 questions (99.4%) during the pretraining and post-training assessments. The Multiquest system identified nine (0.02%) of these question responses as unrecognisable. These responses were therefore independently marked by two evaluators. There was 100% agreement between the evaluators on the intended response in all nine cases.

Overall, there was a significant increase in knowledge of obstetric emergency management following training; the mean MCQ score increased by 20.6 points (95% CI 18.1–23.1,  $P < 0.001$ ). One hundred and twenty-three of the 133 (92.5%) participants who completed both assessments showed an increase in MCQ score. Out of the remaining ten, two (1.5%) had the same score pretraining and post-training and eight (6.0%) showed a decrease in knowledge following training.

Analysis of the post-training MCQ scores showed no significant effect of either the location of training (two-way ANOVA  $P = 0.785$ ) or the inclusion of teamwork training ( $P = 0.965$ ) on mean MCQ score (Table 1). There was no significant interaction between the locality and teamwork

training ( $P = 0.958$ ). Adjustment for differences in staff groups and/or inclusion of the preintervention score as a covariate left the findings unchanged (data not shown).

Prior to training, there were significant differences in mean MCQ scores between the four staff groups ( $P < 0.001$  by one-way ANOVA; Table 2). The mean score for the senior doctors was higher than each of the other three groups (Scheffe multiple comparison tests  $P < 0.001$  for each); no other pairs of staff groups differed significantly (minimum  $P = 0.995$ ), that is before training senior doctors had greater knowledge of obstetric emergencies than all other staff groups, which were all similar. As might be anticipated, the changes in MCQ (post-training minus pretraining) were negatively correlated with the pretraining scores ( $r = -0.36$ ). This was reflected in the changes across the staff groups; senior doctors, for example, with the highest initial scores, had the lowest mean change (Table 2).

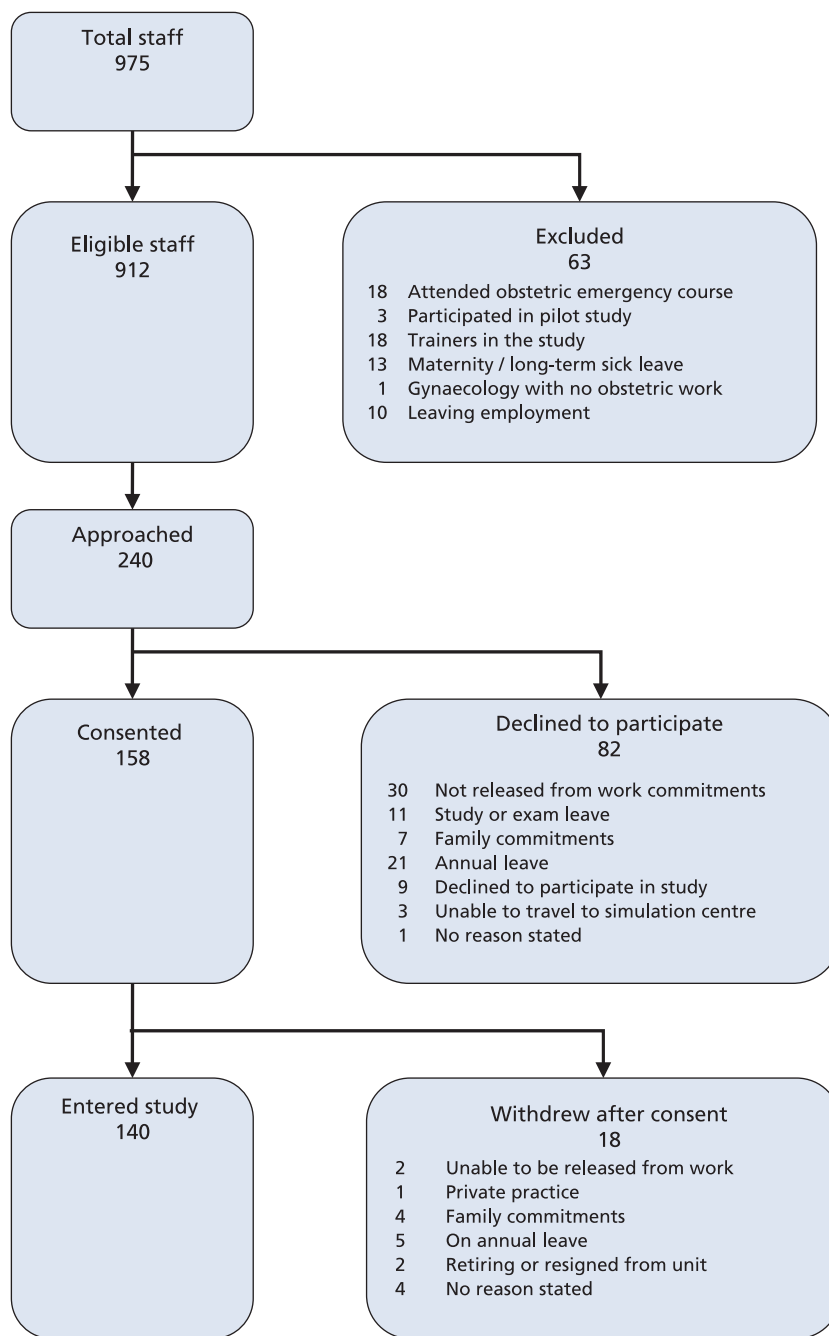
However, there were no significant differences between the staff groups in respect of their relative responses to the four training interventions. This was assessed by including staff  $\times$  training group interactions in the analysis of the post-training scores (Table 3); no significant effects was found (minimum  $P = 0.266$ ).

There was a statistically significant improvement in scores for all individual components of the knowledge assessment, except the management of breech presentation (Table 4). There was, however, no significant effect of either the locality of training or the inclusion of teamwork training on any of the individual components of the MCQ scores (data not shown).

## Discussion

The present study has showed a significant improvement in participants' knowledge following multiprofessional obstetric emergency training. None of the four training interventions appeared to be superior in terms of knowledge gain. The standardisation of the training courses meant all participants, regardless of the training intervention they attended, received the same clinical teaching.

This study's objective was to explore the effect of training on knowledge using MCQs. They (MCQs) are recognised as an efficient method to objectively assess knowledge; a short assessment allows a breadth of sampling of many subject areas. However, MCQs have been criticised as being unfair and promoting factual regurgitation over higher order thinking.<sup>8</sup> The true/false format used in this study has drawbacks, namely guessing and the cueing effect; however, guessing is discouraged through the use of negative marking<sup>9</sup> as used in our study. A criticism of the validity of MCQs, and therefore our study, is again that testing cognitive knowledge does not guarantee competence. Nonetheless, it has been demonstrated that knowledge of the cognitive domain is the single best



**Figure 3.** Recruitment.

determinant of expertise and best assessed using written test forms.<sup>8</sup>

Training has been defined as the systemic acquisition of knowledge (what we think), skills (what we do) and attitudes (what we feel) that leads to improved performance in a particular environment.<sup>7</sup> Kirkpatrick<sup>10</sup> describes four levels for evaluation of the effect of training programmes: Level 1 Reaction (satisfaction following training), Level 2 Learning (MCQ

test, skill acquisition), Level 3 Behaviour (patient care) and Level 4 Results (patient outcomes). Our study only reaches Kirkpatrick Level 2. Previous research has also reported an increase in knowledge (Kirkpatrick Level 2) following obstetric emergency training (MOET);<sup>11,12</sup> however, knowledge assessments were not multiprofessional and were only completed by nine obstetricians in Bangladesh<sup>11</sup> and eight in Armenia.<sup>12</sup> In a further study, participants reported improved

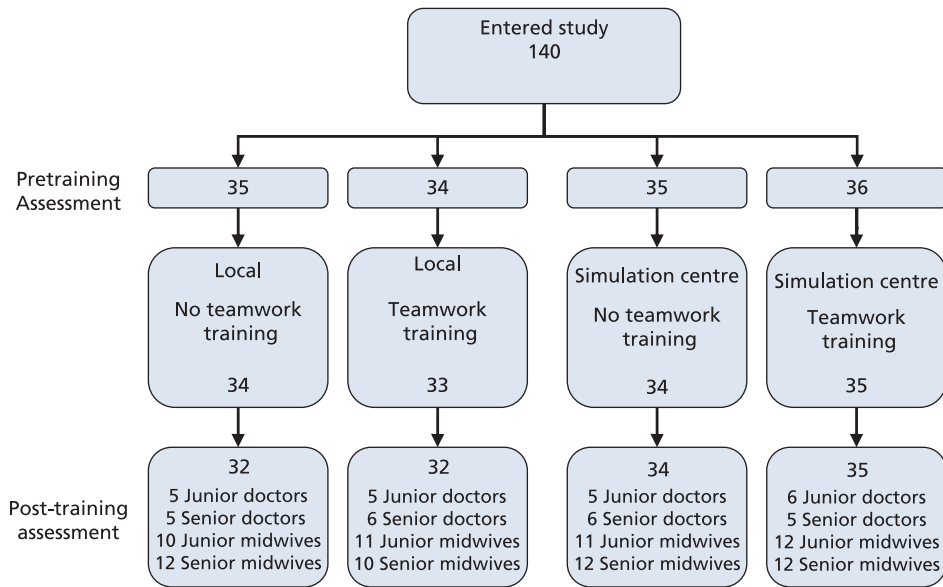


Figure 4. Flow of participants through the study.

subjective comfort (Kirkpatrick Level 1) when managing obstetric emergencies 1 year post-training (ALSO).<sup>13</sup> Unlike the presented trial, participants in the above studies<sup>11–13</sup> were not randomised to receive training but had already demonstrated a motivation to learn by enrolling on an obstetric emergency training course; this may have had influenced the findings.

The gold standard evaluation of any obstetric training programme would be to demonstrate an improvement in maternal or neonatal outcome following the instigation of training. Our study does not reach this goal, however, the clinical training evaluated during the study was based on a multiprofessional training course associated with an improvement in neonatal outcome as determined by Apgar scores and rates of neonatal hypoxic-ischaemic encephalopathy.<sup>14</sup> These findings<sup>14</sup> following the instigation of training would fall into Kirkpatrick level 4.<sup>10</sup>

Our study found senior doctors to have the greatest knowledge of obstetric emergency management prior to training. In the UK, senior obstetricians tend only to be involved in the care of women with complicated pregnancies, in contrast,

Table 2. Mean MCQ scores pretraining and changes (completers only)

Group	Mean (SD)	Change (SD)	n
Junior doctors	75.5 (15.7)	+24.9 (14.5)	21
Senior doctors	109.4 (12.9)	+16.9 (7.6)	22
Junior midwives	74.7 (18.0)	+17.9 (13.4)	44
Senior midwives	74.3 (19.7)	+22.9 (17.5)	46

midwives predominately focus on normal birth. It is therefore understandable that senior doctors demonstrated the greatest knowledge of obstetric emergency management prior to training. The lack of improvement in post-training scores for the management of breech presentation may have been because the breech pretraining scores were high and there was a ceiling effect on future knowledge acquisition.

Attempts have been made to objectively evaluate the effect of high-fidelity emergency training courses in other specialties.

Table 3. Mean pretraining and post-training MCQ scores by training intervention

	Mean MCQ score (SD)		Total
	No teamwork	Teamwork	
<b>Local hospital</b>			
n	32	32	64
Pre	80.8 (22.2)	82.3 (20.7)	81.5 (21.3)
Post	101.5 (22.3)	101.6 (21.1)	101.5 (21.5)
Change	+20.8 (15.1)	+19.3 (15.6)	+20.0 (15.2)
<b>Simulation centre</b>			
n	34	35	69
Pre	80.0 (20.9)	78.8 (23.5)	79.4 (22.1)
Post	100.7 (20.8)	100.3 (21.7)	100.5 (21.1)
Change	+20.7 (14.6)	+21.5 (13.8)	+21.1 (14.1)
<b>Total</b>			
n	66	67	133
Pre	80.4 (21.4)	80.5 (22.1)	80.4 (21.7)
Post	101.1 (21.4)	100.9 (21.3)	101.0 (21.3)
Change	+20.7 (14.7)	+20.4 (14.6)	+20.6 (14.6)

**Table 4.** Mean pretraining and post-training scores for individual knowledge components

MCQ component (number of questions)	Mean score (SD)		Mean change (95% CI)	Significance
	Pretraining	Post-training		
BLS (15)	5.8 (3.4)	9.2 (2.8)	3.4 (2.9–4.0)	<i>P</i> < 0.001
ALS/maternal collapse (15)	5.1 (3.7)	8.2 (3.4)	3.1 (2.5–3.7)	<i>P</i> < 0.001
Eclampsia (30)	12.9 (5.4)	16.7 (5.1)	3.8 (2.9–4.7)	<i>P</i> < 0.001
Shoulder dystocia (35)	16.6 (6.5)	19.7 (5.9)	3.1 (2.2–4.0)	<i>P</i> < 0.001
Breech presentation (10)	7.6 (2.0)	7.9 (1.7)	0.3 (–0.1 to 0.6)	<i>P</i> = 0.164
Twin pregnancy (15)	4.7 (2.7)	5.4 (2.2)	0.7 (0.2–1.2)	<i>P</i> = 0.005
Cord prolapse (15)	6.2 (3.4)	7.1 (3.9)	0.9 (0.3–1.5)	<i>P</i> = 0.003
Electronic fetal monitoring (20)	7.5 (4.7)	8.5 (4.2)	0.9 (0.3–1.6)	<i>P</i> = 0.004
Postpartum haemorrhage (30)	13.9 (5.5)	18.3 (5.2)	4.4 (3.5–5.3)	<i>P</i> < 0.001

ALS, advanced life support; BLS, basic life support.

Advance Trauma and Life Support (ATLS) is accepted internationally as a teaching tool in trauma resuscitation and uses high-fidelity training mannequins. However, there are few objective studies to substantiate its effectiveness in improving knowledge and no studies demonstrating improved clinical outcome. One randomised controlled trial compared the performance of 40 medical students, randomised to ATLS course or routine undergraduate tuition.<sup>15</sup> All students answered a 40 question MCQ 3 weeks before and 2 weeks after training. There was a statistically significant improvement in MCQ score only in the ATLS group. This trial demonstrates improved knowledge following ATLS training (Kirkpatrick Level 2) and very much suggests that any form of focused training improves knowledge.

The addition of an extra training day, focusing on teamwork aspects of obstetric emergency management, did not have an effect on the acquisition of clinical knowledge. A team members' knowledge of the concepts of teamwork has been shown to predict better team proficiency.<sup>16</sup> Increased teamwork knowledge, not just clinical knowledge, may therefore improve the management of obstetric emergencies. The wider SaFE study will attempt to answer this question. The present study did not measure knowledge, or proficiency, of teamwork, and it is therefore perhaps understandable that specific additional teamwork training had no effect on clinical knowledge. It is also plausible that given the sample size subtle differences on the effect of team training and location of training were not found to influence outcome. In our opinion, a large cluster randomised controlled trial would be best suited to address this.

## Conclusion

Obstetric emergency training significantly increased knowledge of obstetric emergencies. Whether increased knowledge

related to obstetric emergencies alone has a direct effect on maternal and neonatal morbidity and mortality is uncertain and requires further study. Training at a simulation centre offered no additional benefit to knowledge acquisition than locally conducted training. Delivery of additional teamwork training also had no effect on the acquisition of clinical obstetric emergency knowledge. Nonetheless, this study is the first to demonstrate an objective improvement in midwives' and doctors' knowledge following obstetric emergency training, in part justifying the requirement that all relevant staff participate in annual obstetric emergency training.<sup>17</sup>

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Training Team: Fiona Donald (Consultant Obstetric Anaesthetist), Mark James (Consultant Obstetrician and Gynaecologist), Imogen Montague (Consultant Obstetrician and Gynaecologist).

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Hospital: Katie Harrison (Midwife), Neil Liversedge (Consultant Obstetrician and Gynaecologist); Royal Cornwall Hospital: Joanne Crocker (Midwife), Simon Grant (Consultant Obstetrician and Gynaecologist). ■

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