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Title: MBRRACE in Simulation: An evaluation of a Multi-Disciplinary Simulation Training for Medical Emergencies in Obstetrics (MEMO)

Shortened Title: MBRRACE in Simulation.

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ABSTRACT

Objective: To evaluate the educational impact of a multi-disciplinary simulation-based training program designed to address Medical Emergencies in Obstetrics (MEMO).

Design: Mixed methods evaluation.

Setting: Simulation training centre.

Population or Sample: All participants ($n=140$) were healthcare staff including medical doctors ($n=91$) and midwives ($n=49$).

Methods: Quantitative self-report instruments were administered to participants pre- and post training, exploring: 1. knowledge of, and confidence in, managing a medically deteriorating pregnant patient, and 2. human factors skills self-efficacy. Participants' perceptions of what they learned and its impact on their practice were explored qualitatively.

Main Outcome Measures: Quantitative instruments addressing 1. The management of medical deterioration in pregnancy and 2. Human factors skills for healthcare. Thematic analysis of qualitative data.

Results: Participants showed significant improvement in management of medical deterioration in pregnancy ($p=.003$) and self-efficacy in their human factors skills ($p=.004$), particularly in the areas of leadership, communication and teamwork. Thematic analysis of participants' self-reported learning and application to practice revealed four themes including: multi-disciplinary teamwork; communication; leadership; and clinical skills.

Conclusions: We present the first multi-disciplinary training programme to target medical emergencies in obstetrics. This simulation-based training improves participants' clinical management of medical deterioration in pregnancy alongside improving their human factors skills. This flexible training is responsive to changing national needs and contextualises the MBRRACE findings for healthcare staff. It is a promising avenue for improving patient care in such complex settings and reducing the rates of in-direct death.

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Keywords: Pregnancy, Multidisciplinary Training, Simulation

INTRODUCTION

Each day worldwide more than 800 women die from preventable causes associated with pregnancy and childbirth.(Organization and UNICEF, 2015) In the UK, maternal death is classified by cause: deaths as a result of obstetric causes, related only to the pregnancy, are known as 'direct deaths', while those occurring as a result of pre-existing or new-onset medical conditions are known as 'indirect deaths'. Over the past 15 years, despite improvements in direct death rates, there has been no significant fall in the indirect death rate, which contributes to over two-thirds of all maternal deaths in the UK (Knight et al., 2014). The leading causes of indirect maternal death in the UK are cardiac disease, neurological conditions, mental illness, and other medical conditions (Knight et al., 2014).

The MBRRACE report identified serious gaps in clinicians' human factors skills, including communication, leadership and teamwork, which contributed to maternal death (Knight et al., 2014). Specifically, three factors were highlighted as crucial to high quality care: early recognition of the deteriorating pregnant woman, prompt involvement of senior clinical expertise, and effective multidisciplinary team working (Manktelow et al., 2016). The MBRRACE report calls for the need for multi-disciplinary training to improve team working and reduce maternal death, the rationale being *'those who work together should train together'*, in order to foster understanding, knowledge and respect across disciplinary boundaries. Simulation is also recommended as the most appropriate and safe modality to train and teach both the technical and human factors skills involved in managing deteriorating pregnant women (Knight et al., 2014, Manktelow et al., 2016, Bates et al., 2009).

Current educational training packages for managing women with emergencies during pregnancy focus predominantly on obstetric emergencies (Johanson et al., 2002, Draycott et al., 2008). They do not target situations that arise due to 'indirect death', which is where most maternal deaths occur. More importantly, for every maternal death, there are 20-50 maternal near misses, along with high morbidity (Acosta et al., 2014). The specific challenges in 'indirect death' involve not only the complexity of two patients (both the mother and the unborn baby), but also multiple health professionals from different professional backgrounds working together to manage this unfamiliar working situation. With this in mind, and in direct response to the training needs highlighted in the MBRRACE report (Knight et al., 2014), we developed a multi-disciplinary simulation training program designed to help inter-disciplinary professional teams manage a pregnant woman with a medical emergency.

This study aimed to investigate the impact of the training on: 1. participants' knowledge of, and confidence in, managing a medically deteriorating pregnant patient, and 2. development of participants' human factors skills. Participants' perceptions of their own learning and its impact on practice was qualitatively explored.

METHODS

Study design

This study was a mixed methods evaluation of a simulation-based interprofessional educational training course designed to improve management of medically deteriorating pregnant women.

Participants

Training was delivered to 140 clinical staff comprised of medical doctors (n=91) and midwives (n=49). Over 90% of trainees were health professionals working across South London. Each session was attended by an average of nine participants (range=6-18).

Educational Intervention

The intervention is designed as a one-day simulation training course. Both the course faculty and participants are multidisciplinary. The simulated environment is realistic and contains standard clinical equipment reflective of that found in our local hospital setting. The day begins with an introductory lecture contextualising both the course in terms of the MBRRACE report (Knight et al., 2014), and the role of simulation in clinical education, with some conceptual exploration of human factors and non-technical skills. The format of the course and roles and expectations of both the faculty and course participants are explained at this stage, to enhance psychological safety.(Rudolph et al., 2014) This is followed by a practical orientation session to the Noelle® Maternal Simulator (Gaumard Scientific Co.), the simulation environment and the role of the embedded practitioner (plant). Five simulated scenarios are completed over the course of the day, each involving two or three course participants. While a scenario is taking place, the remaining participants observe the events via a video-link to the debriefing room (figure 1). All trainees participate in at least one simulated scenario. The scenarios are based on cases from the MBRRACE report (Knight et al., 2014), or real cases that have occurred within our institution. A trained actor is the simulated patient in the single mental illness scenario, and the simulated patient in the remaining medical scenarios is the Maternal Simulator (Noelle®). The trained actor is also utilised as the distressed relative in the fifth scenario. After each scenario, a 30-40 minute facilitated debrief takes place using the Diamond Debrief model (Jaye et al., 2015). After the descriptive component, a short period of standardised didactic teaching is provided to cover the technical aspects of the scenario particularly the themes from the MBRRACE report (Knight et al., 2014), before going on to the second part of the debrief focusing on human factors skills. The Diamond Debrief model was chosen as it allows a balanced discussion of both technical/clinical aspects of a scenario as well as an explicitly non-judgemental learner-led framework for approaching reflection and learning around human factors skills. This is important because of the high-stakes nature of many of the clinical scenarios, the interprofessional mix of trainees, and the recognition that there may be strong emotional responses to scenario content.

A summary of the course aims, learning objectives and teaching modalities is displayed in table 1. Narratives of the five specific course scenarios are detailed below:

- **Scenario 1:** set in the antenatal decision unit where a 19 year old primip, now 34/40 gestation feels unwell. She requires urgent fluid resuscitation and antibiotics for the

management of urosepsis and shock. Urgent escalation and admission to intensive care unit and consideration of emergency LSCS for maternal compromise is required.

- **Scenario 2:** a 33 year old primip, at 30/40 gestation on the antenatal ward. She has a recent upper respiratory infection with an increased requirement for her regular asthma inhaler. She requires urgent management of acute asthma and escalation to a high dependence area.
- **Scenario 3:** a 32 year old woman who is 4 days postpartum. She begins to behave differently. The candidates are required to recognise the psychiatric emergency; puerperal psychosis.
- **Scenario 4:** a 25 year old primip, 36/40 gestation with known epilepsy. She has a history of headaches and is admitted on to the antenatal ward. The headache continues to worsen during the scenario and the candidates are required to recognise a subarachnoid haemorrhage. The candidates are required to deliver immediate management and consider the appropriateness of location for the woman.
- **Scenario 5:** a 39 year old mother of three children who presents at 27+3/40 gestation with shortness of breath and chest pain. She is accompanied by her younger sister (*support person for the mother*). She deteriorates further and becomes very distressed stating; “I’m dying”, “I can’t breathe”. The candidates are required to deliver appropriate management of pulmonary oedema whilst managing a distressed relative.

Evaluation Procedure

A total of 15 one-day training sessions were delivered to 140 participants. Ten sessions were delivered during May to September 2015, and a further five in December 2016. At the start of each training day, participants were informed that we were collecting data to evaluate the training. Ethical approval for this work was provided by King’s College London ethics committee (RESCMR-15/16-1561). Participants provided their written consent to participate and were informed of their right to withdraw. Participants’ learning was evaluated using a questionnaire battery (details provided in the measures section), which participants completed at the start of the training day (pre-course), and again at the end of the day (post-course).

Participants were followed up six months after they had attended the training, and asked to complete a qualitative survey about their experience of medical emergencies in practice since attending the training.

Measures

The learning objectives of the training were two-fold (table 1): Firstly, to improve trainees’ medical or technical skills around management of medical deterioration in pregnancy, and secondly to improve participants’ knowledge and awareness of the human factors skills

associated with multi-disciplinary clinical working. Participants' learning in both areas were evaluated using self-report measures detailed below.

Managing Medical Deterioration in Pregnancy

A four item self-report questionnaire was designed to evaluate participants' knowledge and confidence in managing medical deterioration in pregnancy. The specific items were worded as follows: *'I understand how to recognise an acutely deteriorating pregnant woman; I know the components of the Sepsis 6 and their importance; I am aware of the key themes of the MBRRACE-UK 2014 report; I am confident in managing a deteriorating pregnant woman.'* Participants responded to each item on a 7 point Likert scale scoring system from *'totally agree (1)'* to *'totally disagree (7)'*.

Human Factors Skills

At the time of training development there was no validated measure to assess learning of human factors skills, also referred to in the literature as non-technical skills. To address the need to evaluate learning around human factors skills, the research team at the Simulation and Interactive Learning centre, Guy's and St. Thomas' NHS Foundation Trust, developed a self-report questionnaire designed to assess health care practitioners' perception of their own ability to perform the social and cognitive skills that underpin all aspects of clinical working (i.e. human factors skills). Items were designed by an interprofessional team including: healthcare professionals (nurses and doctors), learning scientists, and psychologists. The instrument items focused on key topics identified in the literature as important human factors skills in health care settings (Flin et al., 2008). A pilot, un-validated 15-item version of this tool was available in 2015, which we will refer to as the Human Factors-Pilot Version (HF-PV) (details below), and this formed part of the evaluation battery.

Over the duration of this study, the Human Factors instrument evolved and resulted in a validated, uni-dimensional 12-item tool for the assessment of Human Factors Skills in Healthcare (HuFSHI). Once available, the HuFSHI was incorporated into the pre- and post training questionnaire battery and was completed by participants attending the five courses delivered in 2016. For the purposes of continuity for the evaluation, the original 15-item Human Factors–Pilot version remained in the questionnaire battery delivered to courses in 2016.

Human Factors – Pilot Version

The tool had face and content validity for assessment of performance of human factors skills in busy acute clinical care settings. Items clustered theoretically into three related sub categories: communication and team working; leadership, including situation awareness and decision making; and care and compassion, including stress and fatigue management. Items were presented as statements (e.g. *I am able to communicate confidently using an early warning score system*) and participants rated their agreement with each statement on a 7-point Likert scale from *'totally disagree' (1)* to *'totally agree' (7)*. Ten Items (3,4,5,6,7,8,10,11,12 and 14) were negatively phrased (e.g. *I struggle to demonstrate care and compassion when I am stressed*) and were reverse scored prior to analysis.

Human Factors Skills for Healthcare Instrument

The HuFSHI is a 12-item self-report assessment of participants' human factors skills self-efficacy, which is reliable and valid, sensitive to change following training, and relevant across multiple professional groups (Reedy et al., 2017). For each item, participants are asked to rate how confident they are that they can manage that specific skill (e.g. *Prioritising when many things are happening at once*). Participants rate each item on a scale of one (definitely cannot do) to 10 (definitely can do).

Self-reported Learning and Impact

Following training, participants completed two short open-ended questions asking them to state:

1. What *have you learned* during the training?
2. What *will you change* in your day-to-day working as a result of the training?

Six Month Follow-up – Impact on Practice

Participants were asked an initial binary question: *have you managed medical deterioration in pregnancy since completing training?*

This was followed by two open questions:

1. **If yes**, has the learning from the training helped you manage these cases? Please explain.
1. **If no**, although you haven't encountered medical deterioration in pregnancy since attending the course, has the learning from the training impacted on your routine clinical practice? Please explain.
2. Since completing the training, have you encountered any barriers to implementing any lessons learned?

Data analysis

All analyses were conducted using IBM SPSS (V.22)(IBM, 2013). The data collected in courses delivered in 2015 did not include identifiers for matching individuals' pre- and post data. As such, participants' scores on the instruments Managing Medical Deterioration in Pregnancy and Human Factors–Pilot Version, were aggregated by training day. **Wilcoxon Signed Rank Tests compared changes in the percentage of items participants rated as 'agree' on the Likert scale (i.e. 1-totally agree, 2-strongly agree or 3-agree) pre-and post-training. All items requiring reverse scoring were reversed prior to analysis.**

The Human Factors Skills for Healthcare Instrument was only completed by participants attending courses in 2016, where identifiers were used to match individuals' pre- and post course data. Thus, participants' individual pre- and post scores were compared on this instrument using paired samples t-tests. A significance level of $p=.05$ was set for all analyses. Participants' responses to the qualitative open questions were thematically analysed.

RESULTS

Pre- and post-course questionnaires were collected from 139 participants attending 15 simulation training days. All training was interprofessional. Midwives formed 35% of the participant sample, while 65% were doctors including: obstetricians, medical physicians and

anaesthetists. Participants' sociodemographic information by profession is displayed in table 2. The majority of participants were white females.

Table 3 displays the mean percentage of agreement pre- and post training for two instruments: Managing Medical Deterioration in Pregnancy and Human Factors–Pilot Version. Overall instrument scores and item /sub-category scores are displayed, alongside Wilcoxon signed ranked comparisons of pre and post data.

Overall, participants' reported significantly improved self-confidence on their ability to manage medical deterioration in pregnancy ($p=.003$). Analysis at item level demonstrates a significant improvement in participants' confidence in: managing a deteriorating pregnant woman ($p=.004$); knowing the components of the Sepsis 6 ($p=.009$); knowing the key themes of MBBRACE-UK report ($p=.001$). Participants showed a trend for improvement in recognising an acutely deteriorating woman ($p=.06$), however this may have failed to reach significance due to a ceiling effect, with 90% of participants agreeing with this item pre-training.

Participants reported significantly improved confidence in their human factors skills following training ($p=.004$). Specifically, significant improvements were seen on items relating to: communication and teamwork ($p=.003$); and leadership, which includes decision making and situational awareness ($p=.009$). However, items relating to care and stress and fatigue management showed a trend for improvement, but failed to reach significance ($p=.09$).

A sample of participants ($n=43$) completed the HuFSHI questionnaire pre- and post training. Paired samples t-tests revealed participants' reported significantly improved self-efficacy following training ($M=7.4$, $SD=1.2$) compared to pre-training ($M=6.72$, $SD=1.1$) $t(42)=4.9$, $p<.001$.

Qualitative Self-Reported Learning

Thematic analysis of participants' self-reported learning revealed four prominent and overlapping themes: multi-disciplinary teamwork; communication; situational awareness and decision making; and clinical skills.

What was learned?

1. **Multi-disciplinary teamwork:** The overarching learning within this theme was participants' recognition of the importance of multi-disciplinary teamwork in the management of medical deterioration in pregnancy (e.g. *'the multi-disciplinary team is necessary to treat pregnant women effectively'*; *'we all have different skill sets, we can learn from each other'*). Participants reported a new appreciation for the perspectives of other disciplines (e.g. *'I am now aware that everyone in the team is feeling the stress of the situation'*) and an awareness of the potential barrier of clinical hierarchy (e.g. *'hierarchy needs to be flattened'*; *'be vocal with initiative, do not worry about hierarchy'*).
2. **Communication:** Participants frequently mentioned the importance of good team communication, specifically focusing on clear handovers and sharing the mental model (e.g. *'clear handover to new team members'*; *'give a clear and full handover with one person speaking'*; *'vocalise your assessment of the situation'*; *'share your own mental model'*). Participants reflected on the critical role of effective communication and its impact on patient care (e.g. *'I've learned the importance of clear communication and how effective communication can improve care'*; *'think out loud'*, *'communicate your own actions'*).
3. **Situational awareness and decision making:** Participants' learning points frequently focused on improved understanding of the key components required by an effective leader including: situational awareness, critical and creative thinking, and timely decision making. Specifically, participants frequently reflected on the importance of situational awareness and reported learning techniques to improve it (e.g. *'it's valuable to sometimes stop during an emergency situation and regroup'*; *'stand back and take time out'*).

The importance of critical thinking and not jumping to diagnostic conclusions also featured frequently (e.g. *'Don't make assumptions, think about other causes'*; *'think laterally and get the overall picture of possible differentials'*; *'don't get distracted and go down one path, keep options open'*; *'think out of the box'*). Alongside this need for critical thinking, participants noted the importance of escalating early, despite the risk of being wrong (e.g. *'I have learned to feel confident in my own knowledge, skills and decision making'*; *'I will call escalate early and won't apologise when doing so'*).

4. **Clinical skills:** An overarching strand of this theme was that participants recognised the need to consider potential medical problems in pregnant women (e.g. *I realised that managing pregnant women with a medical emergency is the same as non-pregnant patients, dealing with the medical emergency is essential'*; *look for the signs and symptoms of medical problems not just obstetrics'*). Specifically, participants reported learning about clinical topics addressed during the scenarios, including: the sepsis 6, asthma, pulmonary oedema, seizures during pregnancy and managing and recognising psychosis (e.g. *I learned... 'what drugs to use during an asthma attack'*; *'Cushing's triad'*; *'the difference between epilepsy and eclamptic fit'*; *importance of implementing sepsis 6 in an hour'*). Another strand of this theme was the importance of working systematically when managing medical deterioration in

pregnancy, with an increased focus on the ABCDE approach (e.g. I learned... *'always check ABCDE approach'; 'constant reassessment; systematic approach in assessing unwell pregnant women'*).

What will you change?

Thematic analysis of participants' reports of what they would change in their own practice as a result of training aligned closely with the self-reported learning outcomes. Four main themes were identified: team communication, situational awareness, decision making and clinical skills.

1. **Team communication:** Most of the participants reported that they would change aspects of their communication with colleagues. Specifically, participants focused on changing their own communication, both at critical points in the interaction such as handover (e.g. I will... *'give a clear handover to colleagues when they arrive at emergencies'*) and throughout the interaction (e.g. I will...*'think out loud, be more vocal'; 'vocalise my thoughts on diagnosis'; 'declare my thinking, even if not sure of diagnosis yet'*). In some cases, this improved communication went beyond the scenario (e.g. I will... *'share my experiences with my students'*). A complementary strand within this theme focused on improving the quality of the team communication through changes to their own team working (e.g. I will...*'ensure that I am approachable'; 'listen more to my colleagues'; 'establish what people want from me, do not assume'; 'reflect on my own behaviour and that of others'*).
2. **Situational awareness:** Participants reported that they will implement the specific techniques learned during the course to improve their own situational awareness (e.g. I will... *'be more aware of the situation as a whole'; 'pay closer attention to the situation and be more aware of what I am doing'; 'be aware of the bigger picture'*). This included having a greater awareness of who the leader is in an emergency situation and recognising that it may not be them (e.g. I will... *'try to determine who the leader is in an emergency scenario'; 'know I am not always the leader'*).
3. **Decision making:** The importance of early escalation to senior colleagues was frequently reported in this theme. It appears that this was an area of challenge before, with participants reporting improved confidence and reduced fear and anxiety in their decision to escalate to senior colleagues early and manage the situation (e.g. I will...*'call for help during the early stage during emergency'; 'be more confident, even if not sure what the diagnosis is, I will just address it'; I won't be scared of unwell pregnant women'*). Participants recognised the importance of remaining open to differential diagnosis while treating a pregnant woman, and strive to echo this in their own practice (e.g. I will... *'try to keep an open mind around diagnosis'; 'try not to focus on one diagnosis'; 'keep differentials open'*).
4. **Clinical skills:** Several participants suggested that the training encouraged them to change aspects of their own clinical practice. Most frequently, participants reported being more systematic in their approach to patient assessment (e.g. *'Do ABCDE'; 'taking a structured approach'; using the Sepsis 6 framework'*) and keeping up to date with new clinical knowledge and guidelines (e.g. I will...*'Keep up to date with*

guidelines and medical emergencies'; 'have information about critical response team access; 'check my knowledge of drugs and equipment'). A number of participants also mentioned that as a result of the training they would seek further simulation-based training (e.g. I will.... *'Do more scenarios training'; 'more training to build on this experience'*).

Six Month Follow-up

The follow-up survey was completed by 24 participants; 15 (62%) indicated that they had experienced medical deterioration in pregnancy in their own clinical practice since completing the training. The majority of these were cases of sepsis, with diabetes and cardiovascular disease also reported.

Impact of training on management of medical deterioration in pregnancy in practice

Those participants who had experienced medical deterioration in pregnancy since completing the training reported that, during such incidents, they felt an improvement in the effectiveness in their own communication (e.g. *'I felt better able to effectively communicate with colleagues and to voice my concerns'*) particularly with colleagues from other professions (e.g. *'Interacting with other members of the multi-disciplinary team more effectively'*). Participants also reported an improved clinical knowledge around medical conditions, particularly sepsis, which is a key clinical condition discussed in the MBRRACE report (Knight et al., 2014) (e.g. *'Recent review of management of sepsis helped it to be fresh in my mind - more confident than I might have been otherwise'*). Participants improved their confidence around clinical knowledge and skills, enabling them to lead clinical situations more effectively (e.g. *'I was able to provide a differential diagnosis and keep an open mind to other causes of hypoxia and chest pain'; 'I was able to assess in detail the client during the antenatal booking and alert the appropriate team.'*) Overall, participants reported a greater awareness of the complexity of managing medical deterioration in pregnancy and discussed taking a more active role in maintaining situational awareness and considering the bigger picture (e.g. *'Reminds me to think outside the box, don't assume it is an obstetric problem' and helps to think about possible outcomes and opens the brain for various scenarios although they can present with very simple or common symptom but can actually lead to something much more serious.'*).

Impact of training on practice more generally

Participants who had not encountered a case of medical deterioration during pregnancy in the six months following the training also reported a transfer of skills to other areas of obstetric practice. Some participants reported an *'improvement in their own communication during obstetric emergencies'*, others noted greater confidence in their clinical skills due to the training (e.g. *'I do diabetes pregnancy clinics and am more confident in prescribing anti hypertensives etc. in pregnancy'*).

Barriers to implementation

Alongside a lack of opportunity to translate their learning into practice, two respondents reported specific barriers to implementing changes in their own practice. These barriers

were: *'workplace hierarchy'* and *'new staff members joining the trust not recognising the importance of working together'*.

DISCUSSION

This study evaluated a multi-disciplinary, simulation-based educational program designed to address the training needs highlighted in the MBRRACE report (Knight et al., 2014), specifically, the importance of interprofessional teamwork when managing medical deterioration in pregnant women.

Overall, the findings revealed that the learning objectives of this educational training were successfully met. Specifically, quantitative self-report instruments revealed a significant improvement in participants' confidence managing medical deterioration in pregnant patients following training; including improved knowledge of the key themes of the MBRRACE report (Knight et al., 2014). Participants' human factors skills self-efficacy also significantly improved following training, specifically around the related components of teamwork, communication and leadership.

Participants' qualitative reflections of their experience of training highlighted an increased awareness of the critical role of teamwork in managing medical problems in pregnancy. Specifically, training improved participants' understanding of the human factors skills that underpin multi-disciplinary teamwork (i.e. effective communication, situational awareness, managing diagnostic uncertainty, and demonstrating timely and creative decision making), alleviated some of the fear associated with working beyond their own area of expertise (i.e. pregnant women/medical conditions) and fostered a greater awareness of the importance of a systematic approach to patient assessment. On a practical level, participants gleaned specific techniques to improve their communication and teamwork skills, alongside building their clinical knowledge in the specific training scenarios. The themes identified post training persisted at six-month follow-up, where participants described specific improvement in the management of medical deterioration in pregnant patients and a broader improvement on routine care. Whilst few barriers were reported to implementing these changes in practice, those which did arise (i.e. workplace hierarchy and untrained new team members) could be more explicitly discussed in future iterations of the training.

Participants showed significant improvement and learning around the specific needs identified in the MBRRACE report (Knight et al., 2014), including multi-disciplinary working and early escalation to senior colleagues. Prior to training, 90% of participants rated that they were confident recognising medical deterioration in pregnancy. Although there was a trend for improvement post training, the high pre-training rate resulted in a ceiling effect. Taking this together with participants' self-reported learning, the barrier to managing medical deterioration in pregnant patients may not be a failure to recognise the condition, but rather, well-recognised human factors aspects. These include a fear of conditions outside your own area of expertise, which may contribute to, or be further complicated by, the complexity of working within a multi-disciplinary team.

Strengths

The quantitative self-report instruments were specifically designed by a multi-professional team, including healthcare professionals, psychologists and clinical educators, in order to address the training programme learning objectives. When validated tools could not be identified to measure human factors skills, the research team developed and validated specific tools to meet the evaluation needs of the training (Reedy et al., 2017). In order to gain a deeper understanding about participant learning, beyond the expected learning outcomes addressed in the quantitative battery, participants' own perceptions of what they had learned and how it would influence their own practice were qualitatively explored. This provided a richer evaluation of participant learning and the value of the training for them. Moreover, in the survey completed six months following training, further insights into the practical applications of the training were provided.

Limitations

This evaluation focused on participants' learning and participants' own perceptions of what they will change in their clinical practice. It did not objectively explore the impact of training on clinical practice or system-level staff or patient outcomes. This is predominantly due to the practical constraints around the training programme. Training was not mandatory, and was offered to staff working across all of South London. As such, whole teams, wards or departments were not trained, and so it was not possible to evaluate the impact of the training at a system level. Future work, we believe, should employ observational analysis on wards to explore the impact of this training on clinical practice, alongside evaluating training of whole department teams in order to explore patient-level outcomes.

Interpretation

This simulation-based multi-professional training programme is effective in enhancing both clinical skills and human factors skills, including teamwork, communication and leadership skills. The training is high-fidelity, in that it is reflective of real practice and contextualises the MBRRACE report (Knight et al., 2014) for healthcare staff working in the area of medical deterioration in pregnancy. The training program was specifically designed to be flexible and adaptive to upcoming MBRRACE themes and training needs as they arise. Thus, the programme will remain current and responsive to national needs and learner requests. Furthermore, as the themes highlighted in MBRRACE echo those highlighted in other areas of the world (Moodley et al., 2014, Paily, 2009), the training has relevance to maternity units beyond the UK.

Conclusion

We present the first multi-disciplinary training programme to specifically target the difficulties in recognising and managing factors to reduce indirect maternal death and morbidity, the leading cause of maternal death in the UK. This flexible and responsive educational training programme facilitates learning and improves working strategies during unfamiliar and highly emotive situations, when managing a deteriorating pregnant patient. Furthermore, it provides a platform for multi-professional team training that can improve communication and allow health professionals to reflect on their own contributions and limitations in such complex cases, which improves the quality and safety of patient care.

Practical and research recommendations

Management of medical conditions in pregnancy relies on a multi-professional approach. Delivery of multi-disciplinary team training to all healthcare staff involved in such complex cases can help healthcare providers develop a greater understanding of others' professional roles, and demonstrates the importance of interprofessional teamwork. Furthermore, it provides a space to reflect on approaches to team working, including leadership and professional autonomy, and the impact that these may have on team dynamics and patient care. Future research should evaluate the impact of this training programme on objective outcome measures of medical emergencies in pregnancy.

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Contribution to Authorship: AB developed the training program. AB, TS, JA and GR created the material for the training programme. AB, JA and FL delivered the training and collected the evaluation data. GR, ML and TS advised on the design of the evaluation and developed the evaluation tools. ML conducted data analysis and drafted the first version of the manuscript. All authors contributed to the manuscript and approved the final version.

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Figure 1. Participants engaging in simulated scenario, which is simultaneously observed by fellow participants via video-link to the debriefing room.

Table 1. Multi-Disciplinary Simulation Training for Medical Emergencies in Obsetrics (MEmO)

TEACHING MODALITIES	COURSE AIMS	LEARNING OBJECTIVES
<ul style="list-style-type: none"> • Lectures • Interactive workshops • Hi-fidelity immersive simulation scenarios followed by facilitated debrief using the diamond debrief method(Jaye et al., 2015) 	<p>I. Improving clinical knowledge in acute non-obstetric medical emergencies in pregnant women as highlighted by the MBRRACE-UK 2014 report</p>	<ul style="list-style-type: none"> • Be aware of the main themes arising from the MBRRACE-UK 2014 report • Know and be able to utilise a systematic ABCDE approach to any potentially unwell pregnant patient • Know and understand the symptoms, signs and management of causes of deterioration in pregnant patients as highlighted by the MBRRACE-UK 2014 report
	<p>II. Exploring the core issues of human factors skills in order to strengthen multi-disciplinary teamwork and improve patient safety. Providing a framework for reviewing working environment and its effect on the patient experience and safety</p>	<ul style="list-style-type: none"> • Understand the important human factors skills to improve patient safety through effective teamwork and communication. • Know who and how to call for help in order to escalate an acutely deteriorating pregnant patient to ensure MDT and senior input

Table 2. Participants' sociodemographic information by profession.

	MIDWIVES <i>n</i> =49 <i>n</i> (%)	DOCTORS <i>n</i> =90 <i>n</i> (%)
Gender		
Female	46 (94)	70 (78)
Age		
<25 years	3 (6)	0
25-34 years	14 (29)	62 (69)
34-45 years	16 (33)	26 (29)
45-55 years	12 (24)	1 (1)
>55 years	4 (8)	1 (1)

Table 3. Participants' pre and post training scores alongside a paired samples comparison using Wilcoxon Signed Ranks Test.

INSTRUMENTS	PRE-TRAINING	POST-TRAINING	n	Wilcoxon Paired Comparison
	% Agreement M (Range)	% Agreement M (Range)		
Managing Medical Deterioration in pregnancy	75.0 (33.9)	98.1 (28.6)	15	Z=2.92, p=.003
<i>Recognise deterioration in pregnancy</i>	90.0 (33.3)	98.1 (28.6)	15	Z =1.84, p=.06
<i>Managing deterioration in pregnancy</i>	66.6 (66.6)	93.6 (28.6)	15	Z =2.90, p=.004
<i>Components of Sepsis 6</i>	70.0 (60.0)	98.1 (28.6)	15	Z =2.63, p=.009
<i>Themes of MBRRACE-UK 2014 report</i>	60.0 (44.4)	95.2 (28.6)	15	Z =3.29, p=.001
Human Factors – Pilot Version	72.4 (29.5)	80.6 (39.8)	15	Z =2.89, p=.004
<i>Team Communication</i>	67.2 (32.2)	77.9 (32.5)	15	Z =2.98, p=.003
<i>Leadership</i>	71.3 (36.0)	77.0 (38.1)	15	Z =2.61, p=.009
<i>Care, stress & fatigue</i>	69.2 (40.5)	74.4 (55.5)	15	Z =1.69, p=.09

