Best Practice & Research Clinical Obstetrics & Gynaecology

Simulation and Beyond – Principles of Effective Obstetric Training

--Manuscript Draft--

Manuscript Number:	YBEOG-D-21-44R1
Article Type:	Issue on SDO (GE_DS)
Keywords:	simulation; teamwork; multiprofessional training; communication; human factors
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Revision notes

Highlights

- Poor communication and teamwork contribute towards adverse obstetric outcomes
- Simulation training improves individual and team performance
- Effective training can prevent maternal deaths and improve neonatal outcomes
- Multi-professional team training improves quality of care
- High fidelity simulation models increase training participants' technical competency
- The future of simulation lies in augmented reality and artificial intelligence

Simulation and Beyond – Principles of Effective Obstetric Training

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Abstract

Simulation training provides a safe, non-judgmental environment where members of the multi-professional team can practice both their technical and non-technical skills. Poor teamwork and communication are recurring contributing factors to adverse maternal and neonatal outcomes. Simulation has been shown to improve outcomes and is now a compulsory part of the national training matrix. Components of successful training include involving the multi-professional team, high fidelity models, keeping training on-site, and focussing on human factors training; a key factor in adverse patient outcome. The future of simulation training is an exciting field, with the advent of augmented reality devices and the use of artificial intelligence.

Keywords: Simulation; teamwork; multi-professional training; communication; human factors

Background

Despite decreasing rates of maternal deaths over the last 20 years, maternal mortality remains excessively high. Worldwide, nearly 300,000 women died during pregnancy and childbirth in 2017[1]. According to the World Health Organisation (WHO) 94% of deaths occurred in low and lower-middle income countries, with Sub-Saharan Africa and Southern Asia accounting for 84%[2]. Sadly, the large majority of these deaths were preventable[1]. Maternal mortality is not just an issue of the developing world. The USA has the highest rate of maternal mortality in the developed world[3], and has experienced a significant increase in maternal deaths over the last 2 decades. Reports from The Centers for Disease Control and Prevention (CDC) state that a sobering 2 out of 3 maternal deaths were preventable; with rates of PPH on the rise[4]. In the UK, Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries (MBRRACE) have recognised that poor communication and teamwork, as well as other human factors, have contributed towards maternal deaths[5]. Globally, recurrent themes around lack of team training continue to be an issue. The most recent MBRRACE report highlights that obstetric emergencies require a multidisciplinary approach as well as a senior clinician who takes a 'helicopter view' of the situation. The report recommends skills and drills training[6]. Furthermore, in response to a number of high-profile maternity failings and preventable deaths, the Ockenden report has set out a number of 'immediate and essential actions' for all hospitals, with the aim of improving safety in maternity services in England. The report recommends that 'staff who work together must train together', and that 'trusts must ensure that multidisciplinary training and working occurs'[7].

Simulation training enables members of the multi-professional team to learn both technical and non-technical skills in a safe, non-judgmental environment, with no risk of harm to the patient[8]. Simulation can improve both individual and team performance[9]. A study developed in response to the findings from the 2014 MBRRACE report, which evaluated the effects of multi-disciplinary training for medical emergencies in obstetrics, showed significant improvement in confidence and in managing medically unwell patients. Improvements were also seen in leadership, communication, and teamwork[10].

Although childbirth is relatively safe in the UK and the developed world, obstetric emergencies still occur, and can be catastrophic if not managed appropriately. Training staff to handle these emergencies is an essential principal of risk management, with simulation training a proactive approach in reducing errors and risk in obstetrics[11]. With changes to junior doctors' working hours and clinical exposure, it is imperative that obstetric trainees, and the wider multidisciplinary team, feel both confident and competent to handle such emergencies. There is also growing concern that with less clinical time, trainees are becoming deskilled in certain disciplines such as instrumental birth, with forceps being seen by some as a redundant procedure[12]. This is particularly worrying, as instrumental vaginal birth, when appropriate and performed in a safe manner, avoids the risks associated with caesarean section in the second stage. This is reflected by countries implementing compulsory simulation courses. In the USA, the Accreditation Council for Graduate Medical Education (ACGME) now requires simulation to be used in Obstetrics and Gynaecology training programs[13]. The Royal College of Obstetricians and Gynaecologists (RCOG) have introduced two compulsory courses to the trainee curriculum; Practical Obstetric Multi-Professional Training

(PROMPT) and the RCOG Operative Birth Simulation (ROBuST) course, or equivalent. After the implementation of PROMPT, there was a 50% reduction in hypoxic ischaemic encephalopathy (HIE) in one trust in the UK[14], and a nearly 40% reduction in maternal deaths in Mpilo Hospital, Zimbabwe[15].

Simulation has a significant role to play in training both obstetricians and the wider team. However, simulation isn't always effective[16], and doesn't always improve patient outcomes[17,18]. This chapter will explore why simulation is important, and will present the key principles of successful simulation training by appraising the most up to date evidence and research. We will also consider what the future holds for this increasingly relevant field.

Operative vaginal birth

12% of babies were born by instrumental delivery between 2019-2020 in the UK[19]. Although nearly 1 in 3 nulliparous women have an instrumental birth[20] numbers have declined over recent years, with rates of caesarean section in the second stage of labour increasing globally[21,22]. Worldwide, nearly 30 million of 140 million live births were by caesarean section in 2015; an increase from 16 million out of 132 million live births in 2000[23]. A recent Lancet Series on reducing unnecessary caesarean section has identified lack of experience in instrumental vaginal birth as contributing towards increasing rates, particularly where there is little training or supervision[24]. This can also be attributed in part to reforms in junior doctor training and subsequent loss of clinical skill and lack of confidence. Worries regarding adverse maternal and neonatal outcomes could also play a role[25].

Instrumental birth can lead to significant complications in the mother, such as third and fourth-degree tears, and haematoma formation, and can lead to retinal haemorrhage and skull fractures in neonates. Malposition in labour is the most common reason for second stage caesarean section[26]. Keilland's rotational forceps can be used to overcome this, but its use is declining due to perceived adverse effects[27]. A multicentre trial in the UK will examine outcomes of different rotational birth methods (ROTATE) with regards to their effectiveness and safety. One possible outcome is emergency caesarean section[28]. Caesarean section in the second stage of labour carries significant risks, such as major obstetric haemorrhage, bladder trauma, and uterine angle extensions that can lead to broad ligament haematoma[29]. It can also have serious consequences in subsequent pregnancies, with a 0.5% chance of scar dehiscence in women wishing to have a vaginal birth after caesarean section, risk of placenta praevia and accreta which can lead to major bleeding necessitating hysterectomy, as well as increasing the risk of stillbirth[30]. Women who have had a previous caesarean section tend to request a repeat caesarean[31], which can increase intraoperative complications. In comparison, women who have had an instrumental birth are more likely to have a successful vaginal delivery in their next pregnancy when compared to those who have had a caesarean section (78% vs. 31%)[31]. With increasing rates of caesarean sections worldwide, this is particularly important in low resource settings where caesarean birth can be relatively unsafe, but where fewer assisted vaginal deliveries are performed due to a lack of skilled practitioners[32]. As part of its recommendations, the recent Lancet series identifies that better training, including in assisted vaginal birth, can help reduce unnecessary caesarean[24].

Obstetric trainees tend to perform the majority of 'trials' of instrumental birth, but it has also been shown that decisions made by a consultant obstetrician are important in determining whether to proceed to instrumental birth or second stage caesarean section[20]. Rates of instrumental deliveries are reduced out of hours when senior obstetricians are not always present on labour ward[33]. This could be due to a lack of confidence in performing complex operative vaginal deliveries overnight. Moreover, one study found that instrument placement is suboptimal in nearly 30% of deliveries, leading to prolonged hospital stays and neonatal trauma. It was also associated with greater use of sequential instruments and caesarean delivery, as well as a 4 minute longer decision to delivery interval[34]. Instrumental birth can be a traumatic experience for the mother and her partner, with one study reporting that 51% of women chose to avoid subsequent pregnancies as they 'could not go through childbirth again'[31]. Greater attention should therefore be paid with regards to not only training junior obstetricians in the technical skill of instrumental birth, but also in non-technical skills, such as communicating with patients.

Current RCOG guidance states that 'safe assisted vaginal birth requires a careful assessment of the clinical situation, clear communication with the woman and healthcare personnel, and expertise in the chosen procedure' and that 'obstetric trainees receive appropriate training in vacuum and forceps birth, including theoretical knowledge, simulation training and clinical training under direct supervision'[25]. A promising study performed in the US has demonstrated that forceps simulation training reduced the rates of third and fourth-degree tears by up to 22%[35].

ROBuST

The RCOG has made it compulsory for trainees to attend an operative birth simulation course while in the first 3 years of training, such as ROBuST. The course is intended for delivery at a local level to enable as many trainees as possible to attend, and provides teaching and hands on experience in ventouse, non rotational forceps, Keilland's rotational forceps, and second stage caesarean[36]. Historically, medical training consisted of 'see one, do one, teach one'. In the context of operative birth, a complex procedure requiring both technical skill and clinical judgment that often takes years to develop, this approach is not ideal in terms of patient safety. Instead, ROBuST's aims are to deliver training as part of a coaching model; building upon theoretical knowledge, observing clinical practice, practising on simulation models, and finally performing these in a clinical environment under direct supervision by a competent trainer. It also equips students with non-technical skills, such as communication, and debriefing of a patient, when managing delay in the second stage[36]. The Simulation Training for Operative Vaginal Birth Evaluation (STROBE) study is currently in progress and aims to study the impact of ROBuST[37]. With this in mind, it is important to consider what makes a successful simulation course.

Principles of Effective Simulation Training

The aviation industry first recognised that serious incidents were due to factors such as poor communication, teamwork, and leadership. In response, crew resource management (CRM) simulation training was developed[38]. It has consequently reduced adverse aviation outcomes beyond those produced by developments in technology[39]. CRM has since been adapted and simulation is now widely used in medicine,

demonstrating that it can improve training in acute medical settings such as the emergency department. One multicentre study of emergency departments in the US has highlighted that formal CRM training improved team behaviours, reduced errors, and improved staff attitudes[39].

Like Emergency medicine, Labour ward requires a multitude of skillsets in order to function, and is a similarly 'high stakes' specialty. After Obstetric CRM training was incorporated into a Patient Safety Program in one study, it improved safety and teamwork[40]. While CRM training in obstetrics has not always been successful[18], it has led to the advent of simulation courses that are more specific to the emergency scenarios experienced on labour ward. Simulation training improves both doctors' and midwives' knowledge in managing obstetric emergencies[41]. In a study conducted in an Obstetric unit in a UK hospital, simulation training was superior to lecture-based training. Participants demonstrated sustained improvement in clinical management, confidence, communication skills, and knowledge. They also reported less anxiety when managing emergencies, and gained transferable skills[11]. Furthermore, while the focus of obstetric simulation training is often focussed on the mother, it has been shown to improve neonatal outcomes. With the introduction of obstetric emergency training courses, rates of low 5-minute Apgar scores and HIE were significantly reduced in a hospital in the South-West of England[42]. Significant improvements in rates of shoulder dystocia[43] and cord prolapse[44] have also been seen after introduction of simulation training.

The goal of simulation training is to improve both maternal and neonatal outcomes. For this to occur, certain features must be present for simulation to be successful and impactful. These include institutional level incentives to training and safety culture,

relevant multi-professional 'in house' training with high fidelity simulation models, and a non-threatening environment where trainees can learn without fear of judgment[45,46]. Educators must keep in mind that elevated stress levels can hinder performance in tasks that require attention and decision making[47]. There are a number of other factors that should also be considered.

Involve the multi-professional team

The definition of team is two or more individuals that work independently and adaptively toward a common role or objective; no single member of the team can achieve one task without the other[48]. Teamwork can be defined as behaviours that facilitate effective team member interaction, including communication, decision making, and situational awareness[49]. Deficiencies in communication and teamwork are major contributors to poor patient care and clinical outcomes[50]. Poor teamwork in obstetrics has also been linked with high levels of litigation, especially in babies with long-term disability secondary to poorly managed shoulder dystocia[51].

With the above in mind, it is imperative that all members of the multidisciplinary team work in synergy to optimise outcomes for both mother and baby. An important component of CRM is that a team needs to be formally established, such as the teams for each shift on labour ward, for teamwork behaviours to be effective[39]. Medicine, and arguably obstetrics in particular, has traditionally been a hierarchical profession, with junior doctors often deferring to their consultants[52]. Multi-professional simulation training is essential in breaking down those barriers and allowing members of the team to communicate without fear of being reprimanded. Indeed, obstetric anaesthetic

residents found it easier to ‘speak up’ after an obstetric simulation course, leading to improved communication and a better learning environment[53].

Multi-professional simulation training improves patient-reported quality of care. A survey of postpartum pregnant women before and after multi-professional training showed an improvement in communication between healthcare professionals, leadership, patient involvement in planning, and an increase in information given to the patient[54]. While there is greater patient satisfaction, participants also report high rates of satisfaction after attending simulation training. Participants observed over a year reported a positive change in the safety environment of the unit and the team[55].

Team efficacy is improved by multi-professional training. In a study reviewing the multi-professional team’s response to an eclamptic patient, the ability to quickly deliver crucial clinical interventions was strongly linked to the capability to work as a coordinated team, even before training. Better teams administered magnesium sulphate almost two and a half minutes quicker than the worse teams, and also showed greater efficiency in other resuscitation skills[56, 57]. Furthermore, teams that administered magnesium quicker exhibited better handover and allocation of tasks[58]. Drills training in postpartum haemorrhage has also been shown to improve team communication[59].

Frequency

Currently, it is mandatory to attend emergency simulation training on a yearly basis, as there will be a natural reduction in knowledge over time. In fact, one study found that clinical knowledge decreased as early as 6 months after simulation training when

participants were asked to complete multiple-choice questions (MCQs) after. However, the decrease was small, and did not change significantly at one year[60]. Frequent training at 3 and 6 months has also been shown to improve management of shoulder dystocia, with trainees retaining their skills no matter what their proficiency prior to training[61].

Location

Simulation conducted in a local unit allows members of the team to practice in their own workplace, making training more realistic. It also helps new members of staff to meet their new colleagues and integrate themselves within the team, familiarise themselves with their environment and learn where to obtain emergency equipment from. It also promotes a culture of patient safety amongst staff [62]. In addition, training costs can be reduced. However, local training effectiveness depends on the quality of the teaching, so units must ensure that they maintain a certain standard.

Sustainability

For any course to have long-lasting impacts upon patient safety, it must be sustainable. Key factors for sustainability were identified when obstetric emergencies training was introduced to the Philippines. These include:

1) The presence of local champions who are committed, motivated, promote training, and have influence within their hospital.

2) Multi-level organisational support and involvement from clinical leads, members of the Hospital Trust board, local policy makers, and national policy makers.
3) Address organisational challenges such as promotion, dissemination of tools introduced through the training, securing staff training, and the cost implications of releasing staff to attend the training.

Although these factors may not be applicable to all countries and health services, the authors' findings are in keeping with current literature[63].

High-fidelity models and realism

Simulation should be as realistic as possible. High fidelity simulation has become a popular training tool for high-risk industries such as healthcare[49]. In a number of emergency scenarios, such as PPH and shoulder dystocia, simulation with high fidelity models has increased the competencies of health professionals[64]. In another study that assessed simulation in shoulder dystocia, training with a high-fidelity mannequins improved delivery rates when compared to routine mannequins[65]. In addition, training with patient-actors has been shown to improve communication and perceived safety[66]. Combining the two would allow members of the team to practice their technical and non-technical skills, as they could practice their communication while also practicing complex tasks, such as internal manoeuvres for shoulder dystocia; a common scenario that obstetricians encounter every day.

Although high fidelity simulation models have their benefits, they are costly. Their use could therefore be limited to developed countries, with a maternal pelvis model costing close to £4,000[67]. In comparison, there are a number of low-cost, low fidelity props that are used in courses (e.g. PROMPT[68]) which range from a blood stained inco sheet to a knitted model of uterine inversion. Although not as high-tech, they clearly demonstrate the problem in the emergency scenario.

Feedback

It is recommended that, as a minimum, debriefing the team post simulation be used to identify what lessons were learned, and to produce strategies for team self-development[41]. Furthermore, one study where simulation was implemented in Israel was able to identify prevailing errors in the management of obstetric emergencies, and as a result they were able to develop a course that specifically addressed the common pitfalls. By giving feedback, errors were reported, and delegates could therefore concentrate on improving their skills during specific tasks[69]. It is essential that feedback is given in a non-judgmental, non-threatening manner.

Human factors

Human factors, ergonomics, and non-technical skills are used to define factors that can impact upon patient safety[70]. They can be institutional and individual. Individual factors include leadership, communication, situational awareness and non-technical skills[70,71]. According to the WHO Curriculum for Patient Safety, errors in patient care are a significant threat to patient safety, with human factors a central issue[72]. The now

infamous Elaine Bromiley case, where a patient died having been admitted to hospital for a routine surgical procedure, highlights how multiple human factors can 'conspire' in a catastrophic way[73]. They must be addressed in simulation training.

Obstetrics is a high stress, fast paced environment where communication can often break down. Poor communication has been highlighted in a number of maternity reports as a factor in adverse incidents[70]. In one study, poor communication was thought to be responsible for over 30% of adverse events in maternity, and also contributed to patient dissatisfaction or threatened litigation[74]. Members of the team should feel empowered to voice their concerns or opinions during patient care. Participants should practice both SBAR (situation, background, assessment and recommendation) and closed-loop communication. SBAR requires the person to introduce themselves, describe their concern, give the background of the patient, their assessment, and ultimately communicate what they need or recommend[75]. Closed-loop communication involves the 'sender' of information requesting an action from the 'receiver', with the 'receiver' repeating the action back to the 'sender', who confirms that the information has been received correctly. The 'receiver' then completes the task and confirms this with the 'sender'[70]. While communication between teams is important, healthcare professionals must also concentrate on their non-technical skills when it comes to communicating with patients. We have already discussed the benefits of patient-actors in this domain[66]. Non-technical skills are of the utmost importance in operative vaginal birth, where excellent communication during a time of great stress and vulnerability with both the woman, her partner, and the wider team is essential. In fact, operative vaginal birth, and not having an active part in decision making, has been identified as a risk factor for postnatal depression[76]. One study identified important factors for operative vaginal

birth; these were communication, relationship with the patient, decision making ability, situational awareness, and maintaining a professional, calm manner[77].

Poor leadership is associated with poor patient outcomes[6,78]. Effective leadership maintains patient safety and team morale[79]. It has been identified that there should be clear, explicit leadership in an emergency scenario, and that leadership should be assigned by experience rather than seniority or grade[80]. A leader should display certain behaviours such as prompt discussion and seeking feedback, make decisions, verbalise plans, delegate appropriately, and provide high quality patient care[81,82]. Leadership roles should be practiced during simulation by members of the team that aren't necessarily the most senior, and are important in allowing the junior registrar or new midwife coordinator to gain confidence in their management.

What does the future hold?

Simulation offers a safe, reproducible learning space for the acquisition of technical and non-technical skills[83]. A recent review on the use of simulators in obstetric ultrasound found that while the demand for simulation-based training was high, its use was much less than expected[84]. While high fidelity, full-motion simulators used in the aviation industry are frequently cited in the medical literature, the majority of medical training programs have evolved from apprentice-type models, with notable difference in robotic surgery where perhaps due to the ergonomics of the surgical console, simulator training is common[85,86]. Medical trainees report barriers including a lack of protected training time, high clinical workload and inconsistent shift patterns as reasons for poor uptake of simulation training[87]. The development of medical

simulators to the standard used in aviation requires engagement, investment and regulatory oversight which has not been forthcoming hitherto in medical education. Surgical training is predominantly opportunistic, unstructured and is often delivered in an apprenticeship style[88]. At best, apprentice-style training is adapted, or augmented by simulation training, but not truly integrated into the curriculum. Weaknesses in individual's training and subsequent performance can be missed if training is not objectively assessed against standardised curricula and regularly reassessed throughout their career[89]. Career-long sub performance has already been demonstrated in obstetric ultrasound, where some operators have been shown to underperform relative to their peers, likely secondary to poor basic training at the start of their careers[90].

The immersive experience offered by aviation-grade and Formula 1 simulators should be the aspiration for future medical training. A group from the University of Rochester have integrated performance metrics into 3D printed training models of the kidney, which can be perfused and simulate bleeding. The models are also non-toxic, so can be used in an operating theatre during surgical training[91]. In time, this could be expanded to surgical training in Obstetrics and Gynaecology.

The relationship between skills obtained in a simulated environment and their translation to the clinic is poorly understood. Transfer ratios, which define the relationship between simulation learning and the real environment, have been studied but need more detail for new platforms[92]. The requirement for objective metrics and validated approaches to training arose from the paucity of evidence highlighted by a literature review[93]. Even with the advent of medical simulation suites and courses such

as RoBUST, most practical medical training is obtained through exposure to events in the clinical environment. This may be directly as the operator, an assistant, or an observer. Validated metrics for the assessment of trainee progress have been investigated in either the simulated or the clinical environment. Surprisingly, there is a lack of understanding of how a trainee's performance in a simulator reflects their performance in clinical practice.

Research has been undertaken in obstetric ultrasound to try to objectively measure how skills translate from a simulated environment to the clinical environment. One group undertook a prospective, observational study of obstetric sonographers at a UK University Teaching Hospital. Participants were either experienced in fetal ultrasound ultrasound, or novice operators. Probe motion data was recorded during the performance of biometry on a mid-trimester phantom. Dimensionless Squared Jerk (DSJ), an assessment of deliberate hand movements, differed significantly between expert and novice operators. It was concluded that DSJ is a robust metric which can differentiate between expert and novice operators in a simulated or clinical setting. This makes it a potential metric for assessment of learning outcomes for a training programme. DSJ, for example, is derived by tracking the trajectory of the ultrasound probe during the performance of obstetric ultrasound[94]. Similar motion-based metrics are utilised in laparoscopic and robotic surgery[95] and such kinematic or motion data can be used to understand fine grained gestures or activities[96].

High fidelity simulation offers the possibility of enhancing the current training models for clinicians in clinical and simulated environments.

Automated tracking of eye and hand movements offers trainers a way to monitor how the trainee interacts with the simulation. Augmented reality and virtual reality will evolve the paradigm by bringing training tools into the clinical environment. Lightweight, comfortable and affordable augmented reality devices, such as Hololens[97], offer the possibility to overlay anatomical or procedural information into the trainee's field of view. The unobtrusive nature of the device means it can be used during training, assessment or during clinical practice. Uses might include laparoscopic surgery, Caesarean section, instrumental birth or ultrasound. These devices preserve the trainee's field of view and can maintain situational awareness while offering suggestions for the next step in the surgical workflow. Hololens can track the user's eye movements and assess signs of cognitive overload and stress, alerting the trainer that more support is required. Hololens can also record the user's view and audio. Such video recordings can be used to assess performance and reflect on areas for improvement. Going further, machine-learning algorithms could identify and prioritise key elements of training to enable personalised learning and automated performance feedback[98]. Interestingly, the simulation environment itself may be a conduit to developing machine learning techniques to assist in clinical practice, with the simulator offering a platform for artificial intelligence agents to explore and learn.

This concept for future training envisages using augmented reality to simultaneously prompt the trainee and alert trainers and team members when performance is deteriorating. Augmented reality devices will allow trainees to be instructed in a reproducible and consistent way outside a simulated environment. Real-time clinical performance could be automatically logged against validated learning

outcomes, appropriate to the stage in training and speciality. Performance can be benchmarked against progress expected in the stage of training, identifying those requiring additional support and those performing beyond their expected level. It is crucial to consider the human factors aspect of how such technology can impact both training and clinical performance all through the development process. Human factors can influence the design of human-machine interfaces, as well as the detail of information presented, and avoid adding burden to the user.

In addition to simulation, telementoring has been demonstrated to be as safe and efficient as on-site training[99], allowing surgical collaboration and teaching between clinicians on opposite sides of the world. Using augmented reality, artificial intelligence, and machine learning, clinicians can virtually 'scrub in' during an operation, and demonstrate how to perform a procedure[100].

Summary

Poor teamwork and communication are recurrent contributing factors towards adverse outcomes[5-7]. Specific to acute obstetrics, rates of instrumental birth are decreasing while rates of caesarean section are increasing[21,22], possibly because of reforms in junior doctor training that have led to a loss of clinical skill, as well as perceived adverse outcomes associated with instrumental birth[24]. This has led to a drive for specific simulation training.

Simulation training enables members of the multi-professional team to learn both technical and non-technical skills in a safe, non-judgmental environment, and improves

individual and team performance[8,9]. Effective simulation can improve both maternal and neonatal outcomes[14,42]. For simulation to be effective, a number of elements should be present in order to maximise learning. Simulation should involve the multi-professional team, occur on a yearly basis as a minimum, and use high fidelity simulation if budget allows. High fidelity models can be used in combination with low-tech props, such as a blood stained inco pad, and, if possible, with patient actors so that participants can practice their non-technical skills. Keeping training 'on-site' allows members of the team to practice in their own workplace and build a rapport with their colleagues, but effectiveness can be influenced by the quality of teaching. Training should also focus on human factors, and feedback given in a non-judgmental manner.

Novel techniques in simulation include monitoring deliberate hand movements when a trainee is learning ultrasound scanning [94]. This could potentially be used to objectively assess other learning outcomes, such as instrumental birth. Augmented and virtual reality devices are becoming increasingly used in medical simulation training and can be used to assess performance. Furthermore, machine-learning algorithms could identify specific areas of training to enable personalised learning and automated performance feedback[98].

The future of simulation is a quickly expanding, promising field, incorporating elements of artificial intelligence, novel virtual reality devices, and telementoring. One must remember that the ultimate focus of simulation training is to improve outcomes for mother and baby. We must continue to assess outcomes to ensure that simulation is an effective and worthwhile experience for all involved.

Practice Points

- Simulation is in many countries a compulsory component of obstetricians' training.
- Simulation improves individual and team performance, and can improve maternal and neonatal outcomes.
- Deficiencies in teamwork and communication have been linked to poor patient care. Training must therefore involve the multi professional team.
- Training should be performed at least annually and in-house as far as possible, as it allows participants to familiarise themselves in their own environment and integrate within the team.
- The use of high fidelity models (phantoms/mannequins) should be encouraged as it contributes to the realism of the scenario. However, the use of low tech props is a valuable addition to the models.
- Human factors are central to patient safety. There should be a focus on human factors training including leadership and communication skills.
- The future of obstetrics simulation training likely lies in artificial intelligence and augmented reality models.

Research Agenda

- Investigate barriers and facilitators to attending training
- Assessment of how best to integrate human factors training into the curriculum
- Leadership and teamwork training in different obstetric contexts.
- Investigate whether the implementation of compulsory simulation training in various established obstetric emergencies and operative birth courses has improved patient outcomes

- Develop and integrate artificial intelligence and augmented reality training into simulation

Conflict of interests

There are no known conflicts of interests to declare.

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