



Hotton, E., O'Brien, S., & Draycott, T. J. (2019). Skills training for operative vaginal birth. *Best Practice and Research: Clinical Obstetrics and Gynaecology*, 56, 11-22. <https://doi.org/10.1016/j.bpobgyn.2018.10.001>

Peer reviewed version

License (if available):
CC BY-NC-ND

Link to published version (if available):
[10.1016/j.bpobgyn.2018.10.001](https://doi.org/10.1016/j.bpobgyn.2018.10.001)

[Link to publication record in Explore Bristol Research](#)
PDF-document

This is the accepted author manuscript (AAM). The final published version (version of record) is available online via Elsevier at <https://doi.org/10.1016/j.bpobgyn.2018.10.001> . Please refer to any applicable terms of use of the publisher.

University of Bristol - Explore Bristol Research

General rights

This document is made available in accordance with publisher policies. Please cite only the published version using the reference above. Full terms of use are available:
<http://www.bristol.ac.uk/pure/about/ebr-terms>

SKILLS TRAINING FOR OPERATIVE VAGINAL BIRTH

Dr Emily Hotton, BSc, MBChB^{a,*}

Dr Stephen O'Brien BM,BS^{a,b}

Professor Timothy J. Draycott MD FRCOG^a

^aWomen's Health, Chilterns, Southmead Hospital, Bristol, UK, BS10 5NB

^bTranslational Health Sciences, Bristol Medical School, University of Bristol, Bristol, UK

***Corresponding author.** Women's Health, Chilterns, Southmead Hospital, BS10 5NB, Bristol,
UK

E-mail addresses: emily.hotton@nhs.net (E.Hotton), stephen.obrien@bristol.ac.uk (S.

O'Brien), tim.draycott@bristol.ac.uk (T.J. Draycott)

Abstract

Skilled, safe operative vaginal birth can substantially improve maternal and neonatal outcomes arising from complications in the second stage of labour and should be available in a diverse range of maternity settings for women across the world. Operative vaginal births are complex, requiring a combination of good technical skills, non-technical skills as well as sensitivity from the accoucher. It is axiomatic that accouchers should be adequately trained and simulation-based training is a promising strategy to improve outcomes and increase the rates of operative vaginal birth. However, not all training is effective and although there are likely to be important lessons from other areas of simulation-based obstetric emergencies training that are generalisable, more research is required to identify effective training interventions for operative vaginal birth. Training for operative vaginal birth should also be operationalised for maximum spread and benefit.

Keywords:

Operative vaginal birth

Effective training

Simulation

Implementation

Patient outcome

Background (Heading A)

Caesarean section is an appropriate option in the second stage of labour when operative vaginal birth (OVB) is deemed inappropriate or unsafe, but also carries significant long term and preventable morbidity both for the mother and her baby. Caesarean section at full dilatation is associated with an increased risk of major obstetric haemorrhage, prolonged hospital stay and neonatal hospital admission when compared to completed instrumental birth [1]. Moreover, OVB when successful requires reduced analgesia requirement, can be expedited more quickly [2] and women are much more likely (>80%) to have a spontaneous vaginal birth in their next pregnancy [3,4]. In addition, repeat Caesarean section may limit maternal choices in future pregnancies, it increases the risk of abnormal placentation which carries significant maternal risks [5] and is associated with an increased risk of unexplained stillbirth in future pregnancies, with a hazard ratio of 1.5 [6]. Therefore OVB may be the best option for the mother and baby in the second stage of labour.

In the developing world, the risks of Caesarean section are exaggerated further by resource restrictions, access to care in future pregnancies and societal attitudes [7]. OVB is underused in countries where pregnant women continue to face hardships in accessing emergency obstetric care and where caesarean delivery can be relatively unsafe [8].

In the USA, Caesarean section rates have plateaued to around 32% over the past few years, [9] which is similar in many high income settings. OVB is currently performed frequently (10 to 15% of births) in the UK, Ireland, France, Spain, Portugal, Canada and Australia; infrequently in Algeria, Sweden and Cambodia (5 to 10% of births); and rarely (less than 5%

of births) in the United States of America (USA) as well as most low and middle-income countries.

The relative merits of forceps versus vacuum for OVB have been summarised in the current RCOG guideline [10], which ultimately recommends: 'the operator should choose the instrument most appropriate to the clinical circumstances and their level of skill. Forceps and vacuum extraction are associated with different benefits and risks. Failed delivery with selected instrument is more likely with vacuum extraction'. Statistics from England indicate that there are fairly equal rates of forceps and vacuum extraction overall (7% and 5.8% respectively) [11].

There are many varieties of forceps and vacuum extraction devices that are available which have different indications and skills required to employ them effectively [12]. It is important to recognise the fundamental similarities between any OVB and the important subtle variations required by each. Decision-making around OVB can be challenging for junior obstetricians who may have little experience with certain instruments, depending on their training location, local 'rules' on instrument use, or access to experienced senior supervision [13].

Indications for OVB include: presumed fetal compromise; to shorten the second stage for women with pre-existing medical conditions that may be affected by a long second stage; maternal fatigue; and inadequate progress in the second stage [10]. These situations are often time dependent, stressful and can be challenging for both clinicians and parents. Obstetricians should be skilled and confident in performing OVBs but this is often not the case [13-17]. Misplacement of ventouse cups away from the flexion point is a common

error, associated with higher rates of failure, morbidity and may reflect sub-optimal training. A mixed prospective and retrospective case series study in 2004 examined training for vacuum extraction within the UK and identified 40% of failed vacuum extraction births were due to suboptimal cup placement [18]. Moreover, a recent observational study across two centres in 2014 reported suboptimal instrument placement in 28.8% of instrumental births [19]. Furthermore, a study that surveyed a random sample of 1600 trainees in the USA about their experience of OVB training established that 25% of trainees with <10 years of experience had not received training on vacuum extraction during their residency, however despite this, 88% of the same group carried out the procedure regularly [20].

OVB requires a variety of technical and non-technical skills by both the obstetrician and the team supporting the birth. OVB is often time-dependent and performed in an emergency setting [10]. Despite this, it is paramount to ensure that the woman and her birth partner(s) feel informed, empowered and supported during their birth experience [21,22]. Studies have shown that a substantial proportion of women still wish for a vaginal birth in a future pregnancy a year after a difficult OVB [23].

Studies exploring trainees' exposure to OVB conclude that simulation and training should logically precede clinical experience, allowing for assimilation of basic knowledge and proficiencies in a safe environment [24,25]. Simulation has been suggested as an important training technique to increase trainees' confidence and skills for OVB [17] but there are few direct data to support simulation-based training for OVB.

Simulation based training for intrapartum obstetric emergencies has led to significant improvements in knowledge, behaviours and outcomes [26-28] and this has been both recognised and repeatedly recommended in national reports [29]. Teamwork training is also strongly encouraged for all maternity staff [30].

This article will review and present the current literature for skills training in OVB and suggest a way forward for training.

OVB: The trainee perspective (Heading A)

When undertaking an OVB, an obstetrician must carefully assess and collate multiple maternal and fetal characteristics including; maternal progress throughout labour, maternal analgesia, fetal wellbeing, presentation and any additional risk factors. Adding to the complexity of this demanding decision-making process is the operator's experience and ability, as well as the level of supervision available [24,31]. OVB skills can be tacit and may be difficult for experienced accouchers to explicitly articulate them, because the skills may have been substantially internalised over many years of practice [32]. Therefore, good training in OVB must equip clinicians with the decision making skills and confidence for accurate, careful OVB [33], as well as the procedural skills.

Systematic reviews into the impact of constant consultant presence on labour ward have demonstrated no improvement for intrapartum outcomes and a recent study could not identify differences in outcomes between births during the day or night, when the proportion of births expedited by middle grade doctors was significantly higher at night [34]. Increased consultant presence has been associated with reductions in Caesarean section

rates in some studies [35,36] and resident consultant cover has been associated with higher OVB rates [37].

The impact of changes in working hours, rotas and consultant presence on training is not yet known. A survey of 52 Irish and Canadian trainees by Crosby et al. in 2017 demonstrated that trainee comfort levels with OVB is positively correlated with numbers performed [17]. This was not the same with trainee confidence levels, suggesting there another factors involved in gaining confidence than merely the number of births performed.

Trainee surveys in the UK have identified a requirement for increased training for management of OVB in the second stage of labour [13,14]. In the USA, surveys have found that >90% of residents reported confidence in performing vacuum extraction, whereas <57% report confidence in performing a forceps birth. 95.9% of those included in the study declared a desire to learn how to perform a forceps birth, expanding their options for OVB [15]. Studies in Australia demonstrated a meaningful increase in forceps use following a targeted training programme, mandating training in forceps prior to training in ventouse, with parallel lectures and simulation training. Although there was no impact on overall maternal or neonatal outcomes, the annual rate of forceps births increased by 1.49 per 100 attempted births ($p < 0.001$) [16]. This suggests that trainees are eager to expand their skills and are receptive to targeted training. It is therefore logical that the next step in developing operative birth training is to provide simulation-based skills training as a core part of the curriculum.

Approaches to training in obstetric emergencies: simulation training (Heading A)

What is simulation training (Heading B)

Simulation training allows for complex “real-life” scenarios to be replicated in a safe, supported, learning environment [38]. The ethos behind simulation learning is that practice is deliberate, mistakes can be made and competence achieved in a safe space [39].

Simulation has become a commonly employed paradigm for training in both undergraduate and postgraduate teaching in medicine [39], particularly for uncommon and high stakes clinical situations that require rapid, accurate and effective care [39]. It is argued that specifically designed simulation training should become part of core curriculum with adjuvant technologies, including video, to promote reflective learning [40].

Evidence for simulation training in obstetrics (Heading B)

There is a substantial body of evidence supporting the use of simulation-based training within obstetrics. Simulation training has been associated with increases in knowledge and skills [27,41], improved teamwork and communication [42,43], improved situational awareness and improved care delivery [44,45].

Interprofessional education has been associated with improved healthcare outcomes [26,46] but there is not a clear causal relationship. A recent Cochrane review concludes that despite several studies alluding to positive results following interprofessional education initiatives, it is impossible to directly link these. This may be due to the complex nature of healthcare systems and the difficulty ascribing improved patient outcomes exclusively to a training intervention [47]. There is currently a Cochrane review underway that seeks to precisely define the impact of emergency training on maternal and neonatal outcomes [48].

Multi-professional simulation training is now recommended in national guidelines [49] and is also incentivised through the NHS Resolution CNST scheme in England [50].

Approaches to skills training (Heading A)

Recent narrative reviews have highlighted the common elements in effective obstetric training and these include: training as a compulsory institution-led requirement; high-fidelity simulation models; and multi-disciplinary attendance [51,52]. Not all training is associated with improved clinical outcomes [53,54] so training must be rigorously and robustly evaluated for real-world effects.

Local versus distance training (Heading B)

Current evidence suggests that local 'in-house' simulation training is the most effective simulation training [51]. This is thought to be related to learning in communities of practice and normalising practice based tools, rather than the transfer of completely new skills and ideas [53]. This compare to training in central simulation centres has not been associated with improvements in clinical outcomes [54,55]. Studies specifically focussing on local obstetric emergency training in settings within the UK, Australia, the USA and Zimbabwe have identified significant improvements in real-life neonatal outcomes including reductions in low Apgar scores, hypoxic-ischaemic encephalopathy and brachial plexus injury [26,46,56,57].

Fidelity (Heading B)

Fidelity is a measure of realism, with the importance of high-fidelity simulation being dependent on the clinical scenario being taught as well as how the trainer and trainee use

the simulation. Multidisciplinary simulation studies in training for shoulder dystocia has demonstrated that training on high-fidelity mannequins is associated with lower rates of brachial plexus injury [28,58]. Using a patient-actor to improve non-technical communication and teamwork skills is a vital component for training in maternity settings as this further increases realism [59].

An example of a high-fidelity mannequin for simulation is the PROMPT Flex® developed by Limbs and Things. This mannequin has been verified as being anatomically accurate and valid [60], and has been used in teaching programs which have demonstrated improvements in outcomes in the UK [61] and the USA [62]. An example of a high-fidelity mannequin for ventouse is used is the MODEL-med Lucy®. These mannequins can aid simulation training but are costly. Low-fidelity mannequins can be used, however there is little robust evidence supporting the use of these.

Cost-effectiveness (Heading B)

There is limited research into the cost-effectiveness of simulation training for OVB. Studies in high-income settings have demonstrated that repetitive, on-site simulation training is cost effective [63]. Important components to training are outlined in this article and we argue these can be achieved in low/middle-income settings. Ensuring a motivated, engaged team of trainers and trainees with a common goal with concomitant local team training and simulation would assist with this. Research has proven that providing comprehensive simulation training is not cheap and this must be considered by centres when embarking on a training programme [64].

Resources for simulation training can often be neglected, for example high-fidelity mannequins require cleaning with soap and water after each use otherwise they are more liable to tear and break. Mannequins and other delicate equipment must be stored in clean, dry containers to reduce damage. If training equipment is to be left for unsupervised use, this should be complemented with clear instructions regarding care and cleaning of resources.

Team training (Heading B)

Multi-disciplinary training is considered the 'gold-standard' for emergency training [30] as has been demonstrated in improved outcomes in umbilical cord prolapse [57] and shoulder dystocia [61]. Evaluating the impact of such training is challenging due to the multi-factorial nature of emergencies and the many ways training programmes are provided [51]. As demonstrated in obstetric emergencies, it is vital that all team members understand the emergency or procedure in order to provide co-ordinated, timely and safe patient care [65].

Application of simulation training to OVB (Heading A)

A safe and timely OVB must be considered a vital skill of any obstetrician. This requires both technical and non-technical skills from the accoucher [24,32]. Traditional 'on-the-job' experiential training alone is not sufficient to successfully train competent and confident trainees [13]. In order to improve OVB training, methods that may help to achieve this. There are significant parallels between OVB and an obstetric emergency and it is reasonable to assume that lessons learnt from obstetric emergency simulation training may be generalised to training for OVB. Specific simulation systems have been developed to aid teaching of OVB worldwide [66-69] but none have reported beneficial impacts on maternal

and neonatal outcomes or long-term sustainability. Assessment of operator competence should also take into account any related maternal and neonatal outcomes.

Technical skills (Heading B)

Technical skills training systems include instrument tracking based training to aid trainees understand trajectories of forceps blades [66] and those which provide real-time feedback on the force used in simulated births [68,70,71]. Forceps birth simulator studies have shown a direct positive correlation between blade placement and number of simulated births [67], demonstrating that an increased exposure to simulation training is associated with an improved technique.

Training programmes that focussed on developing skills specifically for a single OVB technique have been positive. A mixed prospective and retrospective study in 2011 demonstrated that hands-on proactive teaching of forceps in a single maternity unit statistically increased their use by 59% and there were no reported differences in maternal or neonatal outcomes [72]. Another study implemented a formal teaching process to reverse a local decline in the number of forceps births [16]. The training included formal lectures followed by mannequin based simulation training. Subsequent 'real-life' instrumental births were directly supervised until residents were deemed competent, with residents having to be assessed as competent in performing a forceps birth before being allowed to perform vacuum extraction. This demonstrated a significant increase in forceps deliveries after the intervention, with no change in rates of episiotomy, significant perineal trauma or neonatal morbidity [16].

Training programmes should be associated with patient level improvements in outcomes and one retrospective cohort study exploring the effect of formal teaching (lectures and simulation training) was able to demonstrate a significant reduction in third and fourth degree tear rates following forceps births (OR 0.78, $p=0.005$) [73]. Another study demonstrated a significant reduction in neonatal morbidity including: scalp injury and cephalohaematoma (OR 0.14, 95% CIs 0.02 to 0.98, $p<0.05$); SCBU admission (OR 0.72, 95% CIs 0.02 to 0.6, $p<0.05$); and facial injury (OR 0.02, 95% CIs 0.01 to 0.04, $p<0.05$) following formal training for OVB [74].

One teaching model utilised self-reported competency questionnaires [15], but this method of assessment can be subject to bias. Tracking performance in OVB is another training strategy that could be utilised by training programmes [75]. This approach would enable early identification of poor performers, allowing for remedial training with the aim to avoid poor maternal or neonatal outcomes.

Non-technical skills (Heading B)

Non-technical skills such as: task management; decision making; situational awareness; team work and communication are an essential part of OVB and must be considered in order to improve maternal experience and possibly reduce maternal morbidity [31].

Decision-making for OVB is multifaceted with studies identifying key decision-points and assessments required [24,31,76] that should be used to improve training for OVB.

The National Institute for Health and Care Excellence (NICE) intrapartum care guideline recommends a team member is allocated to talk with the woman and her birth partner(s) to

offer support and explain the on-going situation throughout an obstetric emergency [77]. Similar positive behaviours should be provided during an OVB, with team members providing support, explanation and guidance to the woman and her birth partner(s) throughout the birth. Clear communication with the woman and birth partner(s) can make women feel more supported and positive towards their operative birth experience [78].

Despite a discernible need for specific, focused communication between accoucher, woman, birth partner(s) and the wider team, there are no evaluated tools for improving communication. More research is required to develop validated training modules to assist in teaching non-technical skills and to determine how this can be formally assessed.

Set-up (Heading B)

Simulation training should be accessible for all staff and this can be achieved in both low/middle and high-income settings. Tables of suggested equipment and training sessions are shown below.

Table 1 Minimum suggested equipment for simulation training

Simulation training should be undertaken with at least three people per station. One person to act as the operator, another to facilitate the simulation by holding the baby and assisting the birth and a third person who is the trainer. Trainees can therefore learn and practice together acting as both the operator and the facilitator. Having a trainer or senior clinician present to guide and teach any trainees should be the gold standard. If this were not possible then having posters or visual aids to hand to assist in trainee learning would be suitable. These could highlight the important operative steps as well as key learning points

such as episiotomy or bladder care. During a simulation training session it would be advantageous to have one senior clinician or trainer for each station to maximise learning.

The schedule of such training sessions should be individualised for each centre, reflecting the training needs of the staff with stations tailored accordingly. A proposed schedule for training sessions in a calendar year is shown below.

Table 2 Proposed OVB Training Schedule

Current simulation training for OVB (Heading A)

Simulation training in OVB should include both technical and non-technical skills resulting in a positive effect on maternal and neonatal outcomes as well as maternal experience.

The ROBUST course (Heading B)

The RCOG Operative Birth Simulation Training course (ROBuST) [79] is designed to improve outcomes associated with OVB, this was developed by a multi-professional team of obstetricians and midwives. The one-day course and accompanying manual facilitates training in OVB through short lectures, simulated demonstrations and extensive, supported hands-on practice. The course utilises many of the elements associated with positive outcomes in obstetric emergency simulation training, such as simulation, realism and multi-professional learning. Incorporating simulation into OVB training permits trainees to practice and explore the technical and non-technical aspects of OVB in a safe, supportive environment. A rigorous evaluation of the impact of the course is currently underway within four centres in the Southwest of England.

Competency and assessment (Heading B)

Many obstetric emergency training programmes confirm that improvements in patient outcome can be directly associated with skills training [51]; however only a few of these approaches have included both analyses of skill retention over a period of time and changes in behaviour following training [27,80]. To ensure success of training programmes it is important that targeted outcomes are measured. For trainees this is through continued assessment and competence. One of the barriers in assessing the long term impact of formal training in OVB is the constant flow of trainees as they rotate through different hospitals as part of their training rotations [74]. Because of this, outcomes should be actively and prospectively monitored to maintain safety and quality following training [81]. At least one group have used statistical process methods to monitor performance at individual level using routine data sets [75]. Statistical process methods describe a quality control methodology whereby a process is monitored using statistical analysis. This methodology can be applied to any process such as vacuum or forceps delivery, episiotomy, amniocentesis or fetal blood sampling. The result of statistical process methods can provide clinicians with charts monitoring their performance, for example, demonstrating their forceps failure rate against the national average and others in their centre. A mock statistical process chart is shown below in figure 1.

Figure 1 Example of a statistical process chart. The solid line depicts the expected failure rate with the dashed lines representing the outer limits of acceptable performance. Two operators in this mock example are highlighted as being above the acceptable failure range (circled).

Kirkpatrick's model of programme evaluation is one of the most widely used to evaluate training programmes (figure 2). Level 1 refers to the satisfaction from participants following training. Level 2 refers to the knowledge, skills and attitudes learnt from training. Level 3

refers to the change in behaviour, exploring which features learnt during training have been applied to clinical practice. Level 4 refers to the change in outcomes as a result of training.

Figure 2 Kirkpatrick's Model of Programme Evaluation

A 'gold-standard' OVB training programme should have the capability to assess all four levels of evaluation, with continuous monitoring of performance.

Competency assessors (Heading B)

A further challenge is to ensure that OVB trainers and competency assessors have had the necessary skills and training to perform these tasks. The RCOG provides a ROBUST trainers course to ensure that senior clinicians have received appropriate training to provide OVB training sessions. We argue that OVB trainers must be deemed competent and independent in performing direct and rotational OVB techniques.

Summary (Heading A)

OVB is a potentially life saving skill and should not be lost. Current data demonstrates varied rates of OVB across the UK, and internationally. In the UK it is recognised that trainees lack confidence in performing instrumental deliveries and there is no formal training programme in the RCOG curriculum that monitors on-going competence or patient outcomes. Within the UK, trainees are required to perform Objective Structured Assessment of Technical Skills [OSATS] for OVB. This is a workplace-based assessment tool confirming competence however; a trainee only needs to submit one assessment per year for OVB (either for forceps or ventouse delivery). Additionally, there is a lack of outcome monitoring (such as OVB failure or complication rates) and logbooks do not require trainees to document the

total number of OVBs performed annually. This is different to other surgical specialties where trainees are required to keep a logbook of all surgical procedures performed.

Simulation based training for obstetric emergencies can be effective and has been associated with improvements in clinical knowledge and positive impacts on teamworking. Such training has had positive, measurable impacts on maternal and neonatal outcomes and the 'active ingredients of effective training' could be generalised across to training for OVB. Following the success of emergency simulation training, all trainees should undergo formal, local, OVB training using high fidelity mannequins. There is a wealth of evidence to support this form of training and work should continue to validate and operationalise effective training programmes.

Acknowledgements (Heading A)

None required.

Conflicts of interest statement (Heading A)

None.

References (Heading A)

- *1. Murphy DJ, Liebling RE, Verity L, Swingler R, Lancet RPT, 2001. Early maternal and neonatal morbidity associated with operative delivery in second stage of labour: a cohort study. *Lancet*. 2001;358(9289):1203–7.
2. Murphy DJ, Koh DKM. Cohort study of the decision to delivery interval and neonatal outcome for emergency operative vaginal delivery. *Am J Obstet Gynecol*. 2007;196(2):145.e1–7.
3. Bahl R, Strachan B, Murphy DJ. Outcome of subsequent pregnancy three years after previous operative delivery in the second stage of labour: cohort study.

- BMJ. 2004;328(7435):311.
4. Jolly J, Walker J, Bhabra K. Subsequent obstetric performance related to primary mode of delivery. *Br J Obstet Gynaecol.* 1999;106(3):227–32.
 5. Clark EAS, Silver RM. Long-term maternal morbidity associated with repeat cesarean delivery. *Am J Obstet Gynecol.* 2011 Dec;205(6 Suppl):S2–10.
 6. Moraitis AA, Oliver-Williams C, Wood AM, Fleming M, Pell JP, Smith G. Previous caesarean delivery and the risk of unexplained stillbirth: retrospective cohort study and meta-analysis. *BJOG: An International Journal of Obstetrics & Gynaecology.* 2015;122(11):1467–74.
 - *7. Mola G. Operative vaginal birth in the 21st century: a global perspective, in RCOG ROBuST Trainer's Manual. Winter C, Gale A, Siassakos D, Attilakos G, Draycott T, editors. 2013. Cambridge University Press: London.p.1-16.
 8. Bailey PE, van Roosmalen J, Mola G, Evans C, de Bernis L, Dao B. Assisted vaginal delivery in low and middle income countries: an overview. *BJOG: An International Journal of Obstetrics & Gynaecology.* 2017;124(9):1335–44.
 9. Martin JA, Hamilton BE, Osterman MJK, Driscoll AK, Mathews TJ. Births: Final Data for 2015. *Natl Vital Stat Rep.* 2017;66(1):1.
 10. RCOG. Operative Vaginal Delivery: Green-top Guideline No. 26. RCOG, Editor. 2011, RCOG: London.
 11. NHS Maternity Statistics - England, 2013-14 - NHS Digital. 2015 Jan 28. Available from: <http://digital.nhs.uk/catalogue/PUB16725>
 12. Patel RR, Murphy DJ. Forceps delivery in modern obstetric practice. *BMJ. British Medical Journal Publishing Group;* 2004;328(7451):1302–5.
 13. Gale A, Siassakos D, Attilakos G, Winter C, Draycott T. Operative vaginal birth: better training for better outcomes. *BJOG: An International Journal of Obstetrics & Gynaecology.* 2014;121(5):643–4.
 14. Tempest N, Navaratnam K, Hapangama DK. Does advanced operative obstetrics still have a place in contemporary practice? *Current Opinion in Obstetrics and Gynecology.* 2015;27(2):115–20.
 15. Powell J, Gilo N, Foote M, Gil K, Lavin JP. Vacuum and forceps training in residency: experience and self-reported competency. *J Perinatol.* 2007;27(6):343–6.
 16. Skinner S, Davies-Tuck M, Wallace E, Hodges R. Perinatal and Maternal Outcomes After Training Residents in Forceps Before Vacuum Instrumental Birth. *Obstetrics & Gynecology.* 2017;130(1):151–8.
 - *17. Crosby DA, Sarangapani A, Simpson A, Windrim R, Satkunaratnam A, Higgins

- MF. An international assessment of trainee experience, confidence, and comfort in operative vaginal delivery. *Ir J Med Sci.* 2017;186(3):715–21.
18. Sau A, Sau M, Ahmed H, Brown R. Vacuum extraction: is there any need to improve the current training in the UK? *Acta Obstet Gynecol Scand.* Munksgaard International Publishers; 2004;83(5):466–70.
 19. Ramphul M, Kennelly MM, Burke G, Murphy DJ. Risk factors and morbidity associated with suboptimal instrument placement at instrumental delivery: observational study nested within the Instrumental Delivery & Ultrasound randomised controlled trial ISRCTN 72230496. *BJOG: An International Journal of Obstetrics & Gynaecology.* 2015;122(4):558–63.
 20. Bofill JA, Rust OA, Perry KG, Obstetrics WR, 1996. Operative vaginal delivery: a survey of fellows of ACOG. *Obstetrics & Gynecology.* 1996;88(6):1007–10.
 21. Mobbs N, Williams C, Weeks A. Humanising birth: Does the language we use matter? (Internet). *BMJ (Clinical research ed.).* 2018 (cited 2018 Mar 1). Available from: <http://blogs.bmj.com/bmj/2018/02/08/humanising-birth-does-the-language-we-use-matter/>
 22. NICE. Intrapartum care for healthy women and babies. NICE; 2014.
 23. Murphy DJ, Liebling RE. Cohort study of maternal views on future mode of delivery after operative delivery in the second stage of labor. *The American Journal of Obstetrics & Gynecology.* 2003 Feb;188(2):542–8.
 - *24. Bahl R, Murphy DJ, Strachan B. Decision-making in operative vaginal delivery: when to intervene, where to deliver and which instrument to use? *Qualitative analysis of expert clinical practice. Eur J Obstet Gynecol Reprod Biol.* 2013;170(2):333–40.
 25. Yeomans ER. Operative vaginal delivery. *Obstetrics & Gynecology.* 2010;115(3):645–53.
 26. Crofts JF, Lenguerrand E, Bentham GL, Tawfik S, Claireaux HA, Odd D, et al. Prevention of brachial plexus injury—12 years of shoulder dystocia training: an interrupted time-series study. *BJOG: An International Journal of Obstetrics & Gynaecology.* 2016;123(1):111–8.
 27. Crofts JF, Fox R, Draycott TJ, Winter C, Hunt LP, Akande VA. Retention of factual knowledge after practical training for intrapartum emergencies. *Int J Gynaecol Obstet.* 2013;123(1):81–5.
 28. Crofts JF, Bartlett C, Ellis D, Hunt LP, Fox R, Draycott TJ. Training for shoulder dystocia: a trial of simulation using low-fidelity and high-fidelity mannequins. *Obstetrics & Gynecology.* 2006;108(6):1477–85.
 29. O'Neill O. *Safe Births: Everybody's business.* King's Fund; 2008 Jan.

- *30. Draycott T, Crofts, J. Structured team training in obstetrics and its impact on outcome. *Fetal and Maternal Medicine Review*. Cambridge University Press; 2006;17(3):229–37.
- *31. Bahl R, Murphy DJ, Strachan B. Non-technical skills for obstetricians conducting forceps and vacuum deliveries: qualitative analysis by interviews and video recordings. *Eur J Obstet Gynecol Reprod Biol*. 2010;150(2):147–51.
- 32. Bahl R, Murphy DJ, Strachan B. Qualitative analysis by interviews and video recordings to establish the components of a skilled low-cavity non-rotational vacuum delivery. *BJOG: An International Journal of Obstetrics & Gynaecology*. Blackwell Publishing Ltd; 2009;116(2):319–26.
- 33. Draycott TJ, Di Renzo GC. The role of operative vaginal birth in the 21st century and a way forward. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2017;124 Suppl 4:5–6.
- 34. Butler K, Ramphul M, Dunney C, Farren M, McSweeney A, McNamara K, et al. A prospective cohort study of the morbidity associated with operative vaginal deliveries performed by day and at night. *BMJ Open*. 2014; 29,4(10):e006291.
- 35. Reid HE, Hayes D, Wittkowski A, Vause S, Whitcombe J, Heazell A. The effect of senior obstetric presence on maternal and neonatal outcomes in UK NHS maternity units: a systematic review and meta-analysis. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2017;124(9):1321–30.
- 36. Prior M, Draycott T, Burden C. Resident consultant cover may become part of 21st century maternity care, but it is not a panacea. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2017;124(9):1332.
- 37. Henderson J, Kurinczuk JJ, Knight M. Resident consultant obstetrician presence on the labour ward versus other models of consultant cover: a systematic review of intrapartum outcomes. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2017;124(9):1311–20.
- 38. Datta R, Upadhyay KK, Jaideep C. Simulation and its role in medical education. *MJAFI* 2014;68(2):167–72.
- 39. Aggarwal R, Mytton OT, Derbrew M, Hananel D, Heydenburg M, Issenberg B, et al. Training and simulation for patient safety. *Quality and Safety in Health Care*. 2010; 19 Suppl 2:i34–43.
- 40. Ericsson KA. Necessity is the mother of invention: video recording firsthand perspectives of critical medical procedures to make simulated training more effective. *Acad Med*. 2014;89(1):17–20.
- *41. Crofts JF, Ellis D, Draycott TJ, Winter C, Hunt LP, Akande VA. Change in knowledge of midwives and obstetricians following obstetric emergency training: a randomised controlled trial of local hospital, simulation centre and

- teamwork training. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2007;114(12):1534–41.
42. Egenberg S, Karlsen B, Massay D, Kimaro H, Bru LE. “No patient should die of PPH just for the lack of training!” Experiences from multi-professional simulation training on postpartum hemorrhage in northern Tanzania: a qualitative study. *BMC Medical Education*. 2017;17(1):119.
 43. Elliott S, Murrell K, Harper P, Stephens T, Pellowe C. A comprehensive systematic review of the use of simulation in the continuing education and training of qualified medical, nursing and midwifery staff. *JI Libr Syst Rev*. 2011;9(17):538–87.
 44. Watters C, Reedy G, Ross A, Morgan NJ, Handslip R, Jaye P. Does interprofessional simulation increase self-efficacy: a comparative study. *BMJ Open*. 2015;5:e005472.
 45. Lutgendorf MA, Spalding C, Drake E, Spence D, Heaton JO, Morocco KV. Multidisciplinary In Situ Simulation-Based Training as a Postpartum Hemorrhage Quality Improvement Project. *Military Medicine*. 2017;182:e1762–6.
 46. Draycott T, Sibanda T, Owen L, Akande V, Winter C, Reading S, et al. Does training in obstetric emergencies improve neonatal outcome? *BJOG: An International Journal of Obstetrics & Gynaecology*. 2006;113(2):177–82.
 47. Reeves S, Perrier L, Goldman J, Freeth D, Zwarenstein M. Interprofessional education: effects on professional practice and healthcare outcomes [update]. *Cochrane Database Syst Rev*. 2013;(3):CD002213.
 48. Merriel A, van der Nelson HA, Lenguerrand E, Chung Y, Soar J, Ficquet J, et al. Emergency training for in-hospital-based healthcare providers: effects on clinical practice and patient outcomes. *Cochrane Database of Systematic Reviews*. 2016.
 49. RCOG. *Shoulder Dystocia: Green-top Guideline No.42*. RCOG, Editor. 2012, RCOG: London.
 50. NHS Resolution. *NHS Resolution, Maternity incentive scheme (Internet)*. 2017 (cited 2018 Apr 29). Available from: <https://resolution.nhs.uk/maternity-incentive-scheme/>
 - *51. Bergh A-M, Baloyi S, Pattinson RC. What is the impact of multi-professional emergency obstetric and neonatal care training? *Best Practice & Research Clinical Obstetrics & Gynaecology*. 2015;29(8):1028–43.
 52. Siassakos D, Crofts JF, Winter C, Weiner CP, Draycott TJ. The active components of effective training in obstetric emergencies. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2009;116(8):1028–32.

53. Draycott TJ, Collins KJ, Crofts JF, Siassakos D, Winter C, Weiner CP, et al. Myths and realities of training in obstetric emergencies. *Best Practice & Research Clinical Obstetrics & Gynaecology*. 2015;29(8):1067–76.
54. Fransen AF, van de Ven J, Schuit E, van Tetering A, Mol BW, Oei SG. Simulation-based team training for multi-professional obstetric care teams to improve patient outcome: a multicentre, cluster randomised controlled trial. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2017;124(4):641–50.
55. Meriën AER, van de Ven J, Mol BW, Houterman S, Oei SG. Multidisciplinary team training in a simulation setting for acute obstetric emergencies: a systematic review. *Obstetrics & Gynecology*. 2010 May;115(5):1021–31.
56. Crofts JF, Fox R, Ellis D, Winter C, Hinshaw K, Draycott TJ. Observations from 450 shoulder dystocia simulations: lessons for skills training. *Obstetrics & Gynecology*. 2008;112(4):906–12.
57. Siassakos D, Hasafa Z, Sibanda T, Fox R, Donald F, Winter C, et al. Retrospective cohort study of diagnosis-delivery interval with umbilical cord prolapse: the effect of team training. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2009;116(8):1089–96.
58. Crofts JF, Attilakos G, Read M, Sibanda T, Draycott TJ. Shoulder dystocia training using a new birth training mannequin. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2005;112(7):997–9.
59. Luck J, Peabody JW. Using standardised patients to measure physicians' practice: validation study using audio recordings. *BMJ*. 2002;325(7366):679.
60. Edwards S, Cass G, Lenguerrand E, Fox R, Crofts J. Realism and construct validity of novel pelvic models of common gynecologic conditions. *Int J Gynaecol Obstet*. 2013;124(3):270–3.
61. Draycott TJ, Crofts JF, Ash JP, Wilson LV, Yard E, Sibanda T, et al. Improving neonatal outcome through practical shoulder dystocia training. *Obstetrics & Gynecology*. 2008;112(1):14–20.
62. Weiner C, Samuelson L, Collins L, Satterwhite C. 5-year experience with PROMPT (PRactical Obstetric Multidisciplinary Training) reveals sustained and progressive improvements in obstetric outcomes at a US hospital. *Am J Obstet Gynecol*. 2014;210(1):S40.
63. van de Ven J, van Baaren GJ, Fransen AF, van Runnard Heimel PJ, Mol BW, Oei SG. Cost-effectiveness of simulation-based team training in obstetric emergencies [TOSTI study]. *Eur J Obstet Gynecol Reprod Biol*. 2017;216:130–7.
64. Yau CWH, Pizzo E, Morris S, Odd DE, Winter C, Draycott TJ. The cost of local, multi-professional obstetric emergencies training. *Acta Obstet Gynecol Scand*. 2016;95(10):1111–9.

65. Edozien LC. Towards safe practice in instrumental vaginal delivery. *Best Practice & Research Clinical Obstetrics & Gynaecology*. 2007 Aug;21(4):639–55.
66. Dupuis O, Moreau R, Pham MT, Redarce T. Assessment of forceps blade orientations during their placement using an instrumented childbirth simulator. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2009; 116(2):327–33.
67. Dupuis O, Decullier E, Clerc J, Moreau R, Pham M-T, Bin-Dorel S, et al. Does forceps training on a birth simulator allow obstetricians to improve forceps blade placement? *Eur J Obstet Gynecol Reprod Biol*. 2011;159(2):305–9.
68. Leslie KK, Dipasquale-Lehnerz P, Smith M. Obstetric forceps training using visual feedback and the isometric strength testing unit. *Obstetrics & Gynecology*. 2005;105(2):377–82.
69. Macedonia C. Simulation laboratories for training in obstetrics and gynecology. *Obstetrics & Gynecology*. 2003;102(2):388–92.
- *70. Moreau R, Pham MT, Brun X, Redarce T, Dupuis O. Assessment of forceps use in obstetrics during a simulated childbirth. *Int J Med Robot*. 2008;4(4):373–80.
- *71. Moreau R, Pham M-T, Brun X, Redarce T, Dupuis O. Simulation of an instrumental childbirth for the training of the forceps extraction: control algorithm and evaluation. *IEEE Trans Inf Technol Biomed*. 2011 May;15(3):364–72.
72. Solt I, Jackson S, Moore T, Rotmensch S, Kim MJ. Teaching forceps: the impact of proactive faculty. *Am J Obstet Gynecol*. 2011;204(5):448.e1–4.
73. Gossett DR, Gilchrist-Scott D, Wayne DB, Gerber SE. Simulation Training for Forceps-Assisted Vaginal Delivery and Rates of Maternal Perineal Trauma. *Obstetrics & Gynecology*. 2016;128(3):429–35.
74. Cheong YC, Abdullahi H, Lashen H, Fairlie FM. Can formal education and training improve the outcome of instrumental delivery? *European Journal of Obstetrics and Gynecology*. 2004;113(2):139–44.
75. Lane S, Weeks A, Scholefield H, Alfirevic Z. Monitoring obstetricians' performance with statistical process control charts. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2007;114(5):614–8.
76. McQuivey RW. Vacuum-assisted delivery: a review. *J Matern Fetal Neonatal Med*. 2004;16(3):171–80.
77. National Collaborating Centre for Women's and Children's Health (UK). *Intrapartum Care: Care of Healthy Women and Their Babies During Childbirth*. London: National Institute for Health and Care Excellence (UK); 2014 Dec.
78. Siassakos D, Clark J, Sibanda T, Attilakos G, Jefferys A, Cullen L, et al. A simple

tool to measure patient perceptions of operative birth. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2009;116(13):1755–61.

79. RCOG. ROBuST Course programme. 2017. RCOG, Editor. RCOG:London.
80. Bergh A-M, Baloyi S, Pattinson RC. What is the impact of multi-professional emergency obstetric and neonatal care training? *Best Practice & Research Clinical Obstetrics & Gynaecology*. 2015;29(8):1028–43.
81. Sibanda T, Sibanda N, Siassakos D, Sivananthan S, Robinson Z, Winter C, et al. Prospective evaluation of a continuous monitoring and quality-improvement system for reducing adverse neonatal outcomes. *Am J Obstet Gynecol*. 2009;201(5):480.e1–6.