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Qualitative analysis by interviews and video recordings to establish the components of a skilled low-cavity non-rotational vacuum delivery

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Objectives The objectives of this study were to define the components of a skilled low-cavity non-rotational vacuum delivery (occiput anterior, vertex at station +2 or below and less than 45-degree rotation from midline) and to facilitate the transfer of skills from expert to trainee obstetricians.

Design Qualitative study using interviews and video recordings.

Setting Two university teaching hospitals (St Michael's Hospital, Bristol, and Ninewell's Hospital, Dundee).

Participants Ten obstetricians and eight midwives identified as experts in conducting or supporting operative vaginal deliveries.

Methods Semi-structured interviews were carried out using routine clinical scenarios. The experts were also video recorded conducting low-cavity vacuum deliveries in a simulation setting. The interviews and video recordings were transcribed verbatim and analysed using thematic coding. The anonymised data were independently coded by three researchers and compared for consistency of interpretation. The experts reviewed the coded interviews and video data for respondent validation and clarification. The themes that emerged following the final coding were used to formulate a list of skills.

Main outcome measures Key technical skills of a low-cavity non-rotational delivery.

Results The final list included detailed technical skills required for conducting a low-cavity vacuum delivery. The combination of semi-structured interviews and simulation videos allowed the formulation of a comprehensive skills tool for future evaluation.

Conclusion This explicitly defined skills list could aid trainees understanding of the technique of low-cavity vacuum delivery. This is an important first step in evaluating clinical competence in intrapartum procedures.

Keywords Expertise, learning, morbidity, technical skill, vacuum delivery.

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Introduction

The vacuum extractor is increasingly being used as the instrument of choice for operative vaginal delivery. In the UK, 11% of women undergo operative vaginal delivery, and vacuum extraction is used in two-thirds of the women.[1,2] Operative vaginal deliveries are associated with significant maternal and neonatal morbidity.[3,4] Morbidity rises with the sequential use of instruments (vacuum followed by forceps) and failed operative vaginal deliveries (vacuum and/or forceps followed by caesarean section), which are related to inexperience of the operator.[5] The rate of failed operative vaginal delivery has been reported to be as low as 1% in expert hands.[6] However, this has not been reproduced in routine clinical settings where the failure rate with a soft-type vacuum extractor is up to 14%.[7] The disposable rigid vacuum devices have been reported to have failure rates of up to 34%.[8,9] This supports the argument for better training to conduct operative vaginal deliveries.[10,11]

Currently, the trainee operator's level of expertise depends on the number of procedures carried out and on the knowledge, skill and enthusiasm of the teacher. The 'Learning by doing' model has its limitations when transferring information from experts to novices. As one develops expertise in conducting the skilled delivery, it becomes difficult to demonstrate and vocalise the individual components.[12,13] The format of knowledge is different for an expert and a new trainee. While a trainee relies on the declarative knowledge of 'what the tasks involved in a procedure are, an expert has declarative ('what'), conceptual ('relational') and procedural ('how') knowledge.[14,15] Experts have more in-depth knowledge that is accessed at a subconscious level leaving them unaware of the automated strategies. Various techniques have been used in the aviation industry to extract this tacit knowledge. One of the techniques is called applied cognitive task analysis (ACTA).[16,17] This is a process used to deconstruct expert knowledge and adapt it for the needs of an educational package. An ACTA starts by outlining the component tasks for a job and progressively delves into greater detail. The steps and tasks are further described with specifics of how to perform the task and factors that need to be weighed. The final stage involves asking the expert open-ended questions to recall their good and poor experiences. An exploration of these experiences reveals the good practice as well as common errors that should be avoided. We modified ACTA using video recordings as visual aids to stimulate further descriptions of the task. In our study, we have attempted to extract the expert knowledge involved in conducting a vacuum delivery to develop a skills list that will meet the needs of trainees in the early stages of skill acquisition.

Changes in medical training in recent years has led to a reduction in the number of hours spent in training, particularly under direct supervision.[18] Medical training is moving towards a competency-based programme[19] with structured learning objectives, training and assessment of competence. Integral to such a training curriculum is identification of key skills that need to be taught and to set standards for competence assessment.

The aim of this study was to define the skills of a low-cavity non-rotational vacuum delivery to facilitate transfer of skills from expert obstetricians to trainee obstetricians. We have used the Royal College of Obstetricians and Gynaecologists definition for low-cavity non-rotational delivery (adapted from American College of Obstetricians and Gynaecologists classification of forceps deliveries).[20] A low-cavity non-rotational delivery according to this classification is defined as the vertex at +2 or further below the ischial spines, and the occiput is anterior and less than 45 degrees from midline.

Materials and methods

The study was based at two UK university teaching hospitals: St Michael's Hospital, Bristol, and Ninewell's Hospital and Medical School, Dundee. St Michael's hospital has 4500 deliveries per year, and Ninewell's Hospital and medical school has just less than 4000 deliveries per year. Both units are actively involved in teaching of undergraduates and postgraduates and organising the specialist registrar training programme (postgraduate specialist training). The junior medical staff comprise trainees of varying experience. Both units are comparable in terms of background obstetric practice. They have similar rates of induction of labour, use of epidural analgesia, operative vaginal deliveries and caesarean sections. By involving two units from different training regions, we aimed to eliminate the institutional bias towards a particular practice and therefore increase generalisability. The participating expert obstetricians completed their training in units from six deaneries across England and Scotland, adding to the generalisability of the research findings.

The participants for the study were purposively sampled to allow selection of individuals with in-depth knowledge and expertise in vacuum-assisted deliveries. For the purpose of this study, we defined an expert obstetrician as someone who is reputed for his/her expertise in conducting operative vaginal deliveries. A list was drawn of all the obstetricians in the unit who had at least 5 years experience in obstetrics and gynaecology. Clinicians who did not have a regular labour ward session were excluded from the list. The senior midwives who act as coordinating midwives on delivery suite were asked to rank the obstetricians in order of perceived clinical expertise. The selected midwives have a wealth of clinical experience and have overall responsibility for the running of the labour ward, allocating the case load appropriately and calling for obstetric input where they feel necessary. They have observed operative vaginal deliveries performed by obstetricians of all grades of experience and skill. The criterion for ranking was that the obstetrician was competent and skilled at instrumental deliveries. The lists were anonymised to minimise individual bias. The obstetricians who were consistently ranked highly were invited to take part in the study. All the invited experts agreed to participate in the study.

The expert obstetricians and the senior midwives were invited to a semi-structured interview. The obstetricians were asked to describe the technique they employ when conducting an operative vaginal delivery. In addition, they were asked to comment on perceived pitfalls encountered by trainees and on their own 'top tips' in achieving a skilful delivery. The midwives were asked to reflect on the good and bad operative vaginal deliveries they had witnessed with an emphasis on the technique of the delivery.

An identical clinical scenario was given to all the experts. The introduction to the scenario was similar to the case summary given by a midwife when asking an obstetrician to review a woman in the second stage of labour. This was: 'A 25-year-old nulliparous woman at term who has been actively pushing for 1 hour. The vertex is visible, but the woman is tired. She has an epidural, and the cardiotocograph is normal.' Further information regarding clinical findings was provided as requested by the expert. Following interviews, the experts were invited to conduct the vacuum delivery in a simulation setting, and this delivery was video recorded. A low-fidelity simulator (Childbirth simulator S500.1 by gaumard Scientific Co., Miami, FL, USA) was used for the simulation. Using a simulator that is available in most maternity units, we aim to make the identified skills approach transferable to other units.

The interviews and video recordings were transcribed verbatim and analysed using thematic coding. The Atlas.ti 5 computer package was used for coding the data. To make their implicit knowledge and decision-making more explicit, the experts were asked to review their videos and elaborate on the actions and decisions that were not discussed in the interview. The anonymised data were individually coded by three researchers and compared for consistency of interpretation. The themes that emerged following the coding were reviewed by individual experts for respondent validation. Data from all the experts were amalgamated to formulate a list of skills for a vacuum delivery. This skills list was peer reviewed by three senior obstetricians, outside the study regions, known for their expertise in intrapartum care and operative vaginal deliveries. The final skills lists were reviewed by seven junior trainees to assess face validity. The trainees found the skills list easy to comprehend. Figure 1 illustrates the methodology employed to define the skills of a vacuum delivery.

The study was approved by the Multicentre Regional Ethics Committee and by the research and development department at both the units. Written consent was sought from each participant.

Results

The final list includes detailed technical skills required for conducting a low-cavity non-rotational vacuum delivery.

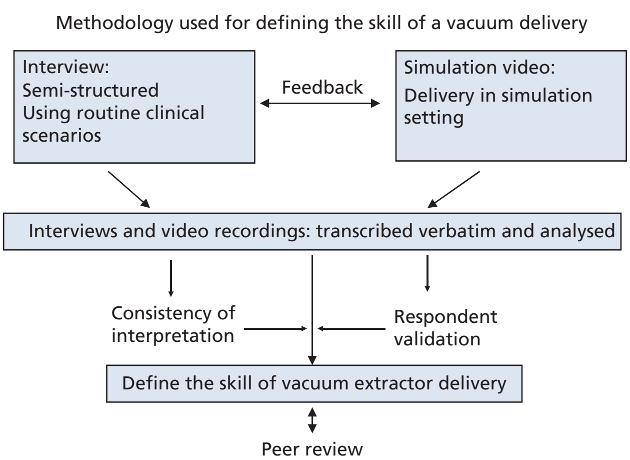


Figure 1. Methodology used for defining the skill of a vacuum delivery.

Verbal articulation of the clinical skills proved challenging, but the combination of structured interviews and simulation videos allowed the formulation of a comprehensive skills tool for future evaluation.

The task of cup application for a soft-type vacuum cup has been used to illustrate the formulation of individual tasks. The experts were asked to describe how they conducted a soft cup vacuum delivery. The task was discussed in detail in the semi-structured interview. Table 1 shows examples of the interview responses of expert obstetricians when describing application of a soft cup, illustrating the difference in individual expert's description of the task. While some of the experts were able to give a detailed description, others were unable to describe the task in a structured manner. The information available from the interviews is likely to appear reasonable to a skilled obstetrician. However, a trainee who is unfamiliar with the procedure needs greater detail. Most of the experts commented that they found it difficult to articulate the task in the absence of a patient or a simulator.

Further information was obtained from the video recordings of experts conducting operative vaginal deliveries in simulation (Video S1). In case of expert P1 (right handed), the video recording added the following information: 'Fold the cup into a vertical slit. Part the labia with the left hand. With the right hand insert, the cup into the introitus, posterior end first. Check the position of the cup and adjust the position

Table 1. Information obtained from interviews describing the procedure of cup application

P1: … gently I hold open the vulva with my right hand… slipping the cup on having squeezed it together into the posterior part of the vulva first… then with my finger I run round to make sure the cap is on at the front

P3: placement of the ventouse… gauging the suction… cup to be on the vertex on the head

P6: Apply the ventouse cup to the flexion point… squeezing into a sort of a narrow gauge push it in… and the flexion point on the head is 3 cm sort of in front of the posterior fontanel… if you say a 6 cm diameter cup, the cup will just about overlie the posterior fontanel…. I will then feel and check that there isn't any vaginal skin caught

P16: …plastic cup on, um put it on… squeeze the cup, put it in half… check vaginal walls, make sure you've not caught the vaginal walls… try to put it as far back on the posterior…. There's more room posteriorly

P17: Apply a ventouse cup over the occiput…. I fold the cup, lubricate it properly on the outside, hold the cup and aim to place it centrally with the silc cup. Apply a ventouse cup over the occipito, check that its OA…. I would apply the ventouse cup to the flexion point

P19: You apply the cup by squeezing into a sort of a narrow gauge push it in and um, then check over the flexion point by moving the cup anteriorly with the index and middle fingers of the right hand.' When added to the interview data, a detailed description of the task of cup application was obtained. Collating the information from both data sources and from all the experts, a detailed skills list for cup application was developed. Where two conflicting opinions arose, both options were reviewed by the three external peer reviewers. Depending on the reviewers' comments if both opinions were considered correct, they were integrated into the skills list as acceptable variations in practice. The opinion not supported by the majority of peer reviewers was discarded. The task of cup application was deconstructed into subtasks to facilitate understanding by trainee obstetricians (Table 3).

Similarly, all the tasks and subtasks of a vacuum delivery were identified. Individual technical tasks and their subtask categories are shown in Tables 3 and 4. The key to a successful vacuum delivery is accurate assessment of the condition of the mother and fetus in conjunction with preparation such as maternal positioning and checking that the necessary equipment is available and in working order. The skills list addresses these aspects of operative vaginal deliveries together with the skill of conducting the delivery (Table 2).

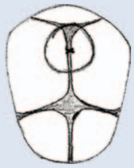
Discussion

When learning a new skill, the most essential factors for learning are perceptual awareness, understanding of spatial relations and a comprehension of underlying mechanical principles.[21] These factors help in developing an understanding of the task, which is the first stage (cognition) of acquisition of motor skill.[22] The second stage is that of integration, when the motor skills unique to the task are applied to avoid ineffective movements. In the final stage of automation, the skill becomes automatic so that the operator does not need to think about individual steps or to rely on external cues. A critical determinant to transfer of skill to various clinical scenarios is the completeness of initial learning of the task.[23] This highlights the significance of clear description and demonstration of a task when a learner starts to learn a new skill. Once learnt, the retention of a skill is crucial. One of the factors that skill retention depends on is the logical sequencing

Table 2. Skills list for assessment and preparation prior to conducting a vacuum extraction delivery

Consent	Ensure the mother understands and agrees with the planned vacuum delivery
Team	A healthcare professional trained in basic neonatal resuscitation (neonatologist/specialist nurse practitioner) should be called if there is concern regarding fetal wellbeing
	One but preferably two midwives should be present
	Depending on the level of competence, the obstetrician may need supervision
Analgesia	Check effective analgesia is present. If not adequate, consider epidural top-up, pudendal block, local infiltration or spinal anaesthetic
	Pudendal block or perineal infiltration should suffice for vacuum deliveries
Check instruments	Check all the equipment is laid out on the trolley in the correct order
	Three clamps (two for dividing the cord and one for clamping the cord for cord bloods)
	Scissors for cutting an episiotomy if required
	Count the swabs
	With all vacuum devices check that vacuum can be achieved
	Warm towels for the baby
Positioning of the mother 	Position the mother in lithotomy once all the preparations are complete
	Lithotomy: hips abducted and flexed and legs suitably supported
	Avoid excessive abduction if the woman suffers from Symphysis Pubis Dysfunction
	Check whether the bed is positioned correctly
	Do not have the mother flat on her back, place a wedge under the right lumbar region
	Position mother's buttocks at the end of the bed
Positioning of the operator	Operators vary in their preference to sit, stand or kneel while conducting an operative delivery
	The principle is that the operator should be well balanced, predominantly using hands and arms
Infection control	Operator should wash hands, wear sterile gloves and hair should be tied back
	Use appropriate protective clothing—gown or apron
	Wash the mother's introitus with water or antiseptic cleaning solution
Catheterisation	Catheterise the mother's bladder
	If Foley's catheter is present, either remove the catheter or deflate the balloon
	Be aware that it may not be possible to catheterise if the head is very low

Table 3. Skills list for cup application of a vacuum extractor device

Lubrication	Lubricate the outside of the cup with obstetric cream or gel
Part the labia	With the index and middle finger of the nondominant hand, part the labia posteriorly or in the middle, stretching the posterior fourchette
Folding the cup (soft-type cup)	Squeeze the cup together into vertical plane to diminish its diameter (see photographs)
	Folding the cup in the horizontal plane is an acceptable practice
Cup insertion	Stretch the lower part of the perineum. Insert the lower end of the cup in the lower part of the introitus
	Then insert the upper part positioning it over the head and below the pubic arch
	It is an acceptable variation to insert the cup laterally into the introitus towards maternal right and then maternal left
Positioning the cup	The aim of correct cup placement is to be able to flex the head as well as to afford traction. Flexion is achieved when the centre of the cup is placed over the flexion point
	The flexion point is on the sagittal suture 3 cm in front of the posterior fontanelle and 6 cm posterior to the anterior fontanelle
	Adjust the position of the cup (with index finger of the dominant hand) to achieve placement over the flexion point
	On the silc or the silastic soft cup, there is a line that should be in line with the posterior fontanelle. Change in direction of this line indicates rotation of the cup
	The Omnicup device™ has indicators for assessing the position of the cup in relation to the flexion point
Pressure increments	Gently push the cup against the fetal head when applying suction to achieve a good vacuum over all areas of the cup
	Increase the pressure to 0.2 kg/cm^2, check again that maternal tissue is not entrapped between the cup and the fetal head, then increase to 0.8 kg/cm^2
	It is acceptable practice to increase the pressure directly to 0.8 kg/cm^2. However, check for maternal tissue entrapment while the pressure is being increased
	For the Omnicup, the pressure should correspond to the green area on the pressure gauge
Checking for vaginal tissue entrapment	Check all around the rim of the cup with the index finger, looking for maternal tissue entrapment. This should be performed before and after pressure increments
Keeping cup in position	Keep a finger on the anterior part of the cup and a finger on the scalp to detect cup detachment. One can detect early cup detachment of the cup if the edges of the cup begin to roll under
	This manoeuvre also helps to establish whether there is descent of the head and not just the scalp with traction

of subtasks[24]—a task should be taught in a manner that demonstrates logical progression. An ill-defined task with poor progression does not facilitate development of expertise.

We have used a novel methodology to extract information from experts to help transfer of knowledge to novice obstetricians. The example of cup application demonstrates that the methodology proved effective in developing comprehensive skills list. We believe the depth of information about vacuum deliveries adds to the information currently available from major Obstetric textbooks. In these books, the principles of correct technique of vacuum extraction are described, but detailed subtask description of each step is not explained. Similarly, the training courses rely on demonstration and 'hands on' practical sessions, but the course manual often lacks detailed descriptions. If the interval between attending the course and practising the skill in the clinical situation is long, the skill learnt may not be retained fully.[25] We have developed a resource that includes a detailed stepwise description of the skill and video demonstrations of the correct technique. This can promote self-directed learning among trainees enabling them to revisit the resource, in their work environment, when learning to perform vacuum deliveries. Further research is required to evaluate the skills identified and develop a training programme and an assessment tool for competence assessment.

We have tried to harness information from senior obstetricians who are reputed to be experts in conducting operative vaginal deliveries. An expert is an individual who consistently performs a task to a high standard with speed and precision.[26] Volume alone does not account for the skill level.[27] In obstetrics, senior obstetricians often conduct fewer operative vaginal deliveries and the deliveries that they conduct are of greater complexity. This ruled out the option to identify expert obstetricians by using the years in service, the number of procedures performed or the rate of complications arising from the procedure. Referring back to the definition of an

Table 4. Skills list for application of traction with a vacuum extractor

Timing of first pull	Gentle traction should be applied during the first contraction when maternal effort is present
Observation with first pull	Assess if there is descent with traction
Timing of traction in relation to contraction	Traction should be applied during the contraction
	Await the onset of expulsive maternal effort before applying traction
	Traction should not be applied between the contractions
Direction of traction	Apply traction in the axis of the pelvis aiming to simulate normal delivery
	Follow a J-shaped curve with the handle of the vacuum device
	Apply downward traction until the head starts to crown (when the widest diameter has gone below the symphysis pubis). Then change to a gradual upward direction
	Traction should be applied at right angles to the plane of the cup, which will be in the correct axis of traction
	Consider changing the direction of traction by a few degrees in the vertical plane to establish the correct direction of traction
Protecting the perineum	As the head is crowning, the perineum should be protected with the dominant hand
	With the thumb and the index finger on either side of the perineum, attempt to bring the perineal tissues into the midline from the side
	The head should be delivered in a controlled and slow manner reproducing the mechanism of normal birth
	Some operators may prefer an assistant to guard the perineum to reduce the risk of cup detachment
Number of contractions anticipated	Delivery should usually be achieved within 3–4 contractions
	Descent should, however, be achieved with each contraction
Assessing need for episiotomy	It is not necessary to perform an episiotomy routinely with a vacuum delivery
	If the perineum is obstructing the delivery of the head, an episiotomy should be considered
	Feel for stretch or give in the tissues of the posterior fourchette. If the tissues feel rigid and a tear appears likely, then consider an episiotomy
	Routinely performing an episiotomy to avoid a tear is not appropriate
Assessing for trauma postdelivery	The perineum should be assessed for tears once the placenta is delivered
	A vaginal and rectal examination should be performed to assess the anal sphincter unless the perineum and vagina are clearly intact
	Assess the baby for trauma. Consider neonatology review if concerned

expert, we believe that the best way to recognise experts is to identify obstetricians who are reputed among the peer intrapartum care team to be consistently good at conducting operative vaginal deliveries.

By targeting expert participants in two ways (interview and video recording), we aimed to maximise the quantity and quality of data. According to Morse,[28] the greater the amounts of usable data that can be obtained from one participant, the fewer participants are required. Having purposively sampled data-rich participants, we anticipated a sample size of ten obstetricians and ten midwives, with the plan to continue recruitment till there was saturation of ideas and no new themes emerged. Saturation was reached with ten obstetricians and eight senior midwives between the two centres.

We have developed the skills list for vacuum delivery because the use of vacuum devices for conducting low-cavity delivery has been increasing over the past two decades. In England, the rate of operative vaginal procedures has remained constant over the years, but the use of vacuum devices has risen.[2] It has been shown that the complications that arise are often related to incorrect technique, and this needs to be addressed with training in conducting vacuum deliveries.[11,29] The methodology can be used for identification of skills involved in conducting non-rotational and rotational forceps deliveries or indeed any clinical procedure.

The potential limitation of this study is that while we have identified the various techniques used by the experts participating in this study, we may not have identified some of the techniques used outside the study regions for soft cup vacuum extraction. We have tried to address this issue by requesting experts from outside the study regions to peer review the findings. We acknowledge that this skills list offers a safe technique of conducting vacuum extraction, and there may be regional or individual variations to the technique described. These variations can be incorporated into the skills list at a local level using the methodology described. Furthermore, this skills list refers to low-cavity non-rotational skills, and additional skills are required for the more complex mid-cavity and rotational deliveries.

Another concern that can be raised is that the deliveries were conducted in simulation setting. We accept that the simulation setting may not provide the complexity of the real clinical environment. Therefore, the interviews were used to discuss the skills experts used in actual clinical settings, and the simulation was used as a tool to identify skills that may not have been verbalised in the interviews. Further work is planned to validate the findings in clinical setting for training purposes. This would inform the trainers of the skills that can be perfected and assessed in simulation setting and the skills that need to be taught specifically for the challenges of the clinical setting. The next step is to develop a training package that will include the described skills list supplemented by video illustrations of the techniques. At present, the skills list illustrates what we believe to be best practice, but there is no direct evidence that this skills list will improve outcomes. However, there is indirect evidence from the surgical domain demonstrating that the use of the principles of cognitive learning can improve knowledge and skill acquisition. We would expect this to apply equally to obstetric practice.[30] The skills list was devised using the principles of ACTA and is consistent with the principles of cognitive learning, which recommend a breakdown of an individual task into sequential subtasks for transfer of a skill from an expert to a novice practitioner. We aim to assess the change in trainees' knowledge and skill following the use of the training package in a future study.

Conclusions

This explicitly defined skills list is an important first step in evaluating clinical competence in intrapartum procedures. This informs curriculum developers of the skills that need to be learned and helps set standards accordingly. These can then be used for developing assessment tools for assessing competence of trainees.

Disclosure of interest

No conflict of interest.

Contribution to authorship

All three authors carried out the study design and thematic coding. R.B. was responsible for data collection, analysis and drafted the manuscript, which was revised by all three authors.

Details of ethical approval

The study was approved by South-West Multicentre Research Ethics Committee (reference number: 04/MRE06/61) on 10 February 2005.

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Supporting information

Additional Supporting Information may be found in the online version of this article.

Video Clip S1. Vacuum delivery in simulation.

Please note: Wiley-Blackwell is not responsible for the content or functionality of any supplementary materials supplied by the authors. Any queries (other than missing material) should be directed to the corresponding author for the article. ■

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