



Development of obstetric anesthesia core competencies for USA residency programs through a Delphi process

Mise au point de compétences de base en anesthésie obstétricale pour les programmes de résidence aux États-Unis grâce à un processus Delphi

Maytinee Lilaonitkul, MBBS · Christopher W. Cosden, MD · John C. Markley, PhD · May Pian-Smith, MD · Grace Lim, MD · Peter Yeh, MD · Pedram Aleshi, MD · Christy Boscardin, PhD · Kristina Sullivan, MD · Ronald B. George, MD, FRCPC

Received: 10 January 2023 / Revised: 5 March 2023 / Accepted: 9 March 2023 / Published online: 3 August 2023
© The Author(s) 2023

Abstract

Purpose *The standard for anesthesia residency training in the USA mainly relies on the Accreditation Council for Graduate Medical Education (ACGME) Outcome Project, a framework that lacks specific directives for subspecialties including obstetric anesthesia. We aimed to identify core competencies in obstetric anesthesiology that can be adapted to different residency training programs to help improve the quality of training and accountability of the institutions within the USA.*

Methods *We identified a preliminary list of competencies from review of existing competency-based obstetric anesthesia training curricula and practice guidelines. We used a modified Delphi methodology to achieve expert consensus among members of the Society for Obstetric Anesthesia and Perinatology education committee. The panellists were asked to evaluate the importance of each competency using a five-point Likert scale, with consensus after two rounds defined at 80% agreement. The responders were also asked at which level of training each competency should be attained.*

Results *The Delphi rounds had 75% response rate and derived 94 competencies that were categorized under the six ACGME domains: patient care (38), medical knowledge (45), system-based practice (two), practice-based learning and improvement (five), interpersonal communication skills (two), and professionalism (two).*

Conclusion *We generated a residency training competency list for obstetric anesthesiology through expert consensus. This list can be used by residency training programs to develop a structured competency-based curriculum with tangible milestones, thereby reducing heterogeneity in the standard of training.*

M. Lilaonitkul, MBBS (✉)
Department of Anesthesia and Perioperative Care, University of California San Francisco, San Francisco, CA, USA

Zuckerberg San Francisco General Hospital and Trauma Center,
1001 Potrero Ave., Room 3C38, San Francisco, CA 94110, USA
e-mail: maytinee.lilaonitkul@ucsf.edu

C. W. Cosden, MD
Alta Bates Summit Medical Center, Oakland, CA, USA

J. C. Markley, PhD · P. Yeh, MD · P. Aleshi, MD ·
C. Boscardin, PhD · K. Sullivan, MD
Department of Anesthesia and Perioperative Care, University of California San Francisco, San Francisco, CA, USA

M. Pian-Smith, MD
Harvard Medical School, Boston, MA, USA

G. Lim, MD
University of Pittsburgh, Pittsburgh, PA, USA

R. B. George, MD, FRCPC
Department of Anesthesiology and Pain Medicine, University of Toronto, Toronto, ON, Canada

Résumé

Objectif *La norme pour la formation en résidence en anesthésie aux États-Unis repose principalement sur le Projet de résultats (Outcome Project) de l'Accreditation Council for Graduate Medical Education (ACGME), un cadre qui ne dispose pas de directives spécifiques pour les surspécialités, notamment pour l'anesthésie obstétricale. Notre objectif était d'identifier les compétences de base en*

anesthésiologie obstétricale qui pourraient être adaptées aux différents programmes de formation en résidence afin d'améliorer la qualité de la formation et la responsabilisation des établissements aux États-Unis.

Méthode Nous avons dressé une liste préliminaire de compétences en passant en revue les programmes de formation axés sur les compétences et les lignes directrices de pratique existants en anesthésie obstétricale. Nous avons utilisé une méthodologie Delphi modifiée pour parvenir à un consensus d'expert-es parmi les membres du comité d'éducation de la Society for Obstetric Anesthesia and Perinatology. Les panélistes ont été invitée-s à évaluer l'importance de chaque compétence à l'aide d'une échelle de Likert à cinq points, le consensus étant défini à 80 % d'accord après deux tours. On a également demandé aux répondant-es à quel niveau de formation chaque compétence devrait être atteinte.

Résultats Les étapes du processus Delphi ont eu un taux de réponse de 75 % et ont permis de déterminer 94 compétences qui ont été classées dans les six domaines ACGME : soins aux patient-es (38), connaissances médicales (45), pratique systémique (deux), apprentissage et amélioration basés sur la pratique (cinq), compétences en communication interpersonnelle (deux) et professionnalisme (deux).

Conclusion Nous avons généré une liste de compétences pour la formation de résidence en anesthésiologie obstétricale grâce à un consensus d'expert-es. Cette liste peut être utilisée par les programmes de formation en résidence pour élaborer un programme structuré axé sur les compétences avec des jalons tangibles, réduisant ainsi l'hétérogénéité dans la norme de formation.

Keywords competency-based · Delphi process · medical education · obstetric anesthesiology · residency training

Cesarean delivery is the most common major surgical procedure performed worldwide. In the USA, about 1.15 million Cesarean deliveries are performed annually, making obstetric anesthesia an integral part of the clinical practice for many anesthesiologists in both academic and private settings.¹ Despite advances in medical care, maternal deaths continue to rise in the USA, 60% of which are preventable.² To better address the needs of the population and the health care system in which physicians work, competency-based medical education (CBME) has been adopted and exists in various forms in residency training programs in the USA and other

countries. This outcome-based training approach is patient-centred and focuses on achievement of competencies that trainees need to best serve their communities.^{3,4}

Currently, the standard for anesthesia residency training in the USA relies on the Accreditation Council for Graduate Medical Education (ACGME) Outcome Project. Although this framework focuses on general outcomes, it lacks specific directives for subspecialties including obstetric anesthesia.⁵ A survey of 93 anesthesia residency training programs in the USA revealed that residents spend on average 2.7 months in obstetric anesthesia, but clinical exposure varies significantly between different programs.⁶ Without specific guidelines to determine competency, residency education relies mainly on the in-training examination and the American Board of Anesthesiology (ABA) exam topics, which lack practical skills assessment and tangible milestones. Furthermore, a recent national study has shown a decrease in pursuit for higher-level obstetric anesthesia fellowship training among residency graduates,⁷ highlighting a greater need to maximize the efficiency of residency training with clear expectations of training outcomes within this subspecialty.

A competency-based residency training curriculum in obstetric anesthesia is established and explicitly defined in some countries including Canada, Australia, and European nations.^{8–12} Such programs are oftentimes implemented at a national level and are regulated by the corresponding governing professional bodies. Structurally, however, the training approach in the USA is more decentralized when compared with these countries. Although the minimum time spent on obstetric anesthesia rotation and case numbers are defined by the ACGME, there are no specific directives on competencies to be achieved during training. Individual USA residency programs, therefore, determine their own standards of a competent trainee. These pre-existing curricula, however, are not always directly applicable to the USA context when considering the differences in the health care systems, population needs, and medical education training structure.

To fill this gap in medical education training, we aimed to identify the core competencies in obstetric anesthesiology using a Delphi expert consensus approach and to determine the level of training at which the competencies are expected to be achieved.

Methods

This study was certified exempt by the Institutional Review Board at the University of California San Francisco (study #20-32093).

Survey development

We generated a preliminary list of 102 competencies from review of existing competency-based obstetric anesthesia training curricula and practice guidelines from the National Societies of Anesthesiology and professional bodies. These resources included the Initial Certification in Anesthesiology contents as outlined by the ABA,¹³ the National Curriculum for Canadian Anesthesiology Residency,⁹ the Curriculum for a Certificate of Completion of Training in Anaesthetics, UK,¹¹ and the Anaesthesia Training Program Curriculum, ANZCA.¹² We subsequently categorized these into the six ACGME domains of core competencies (patient care, medical knowledge, interpersonal skills and communication, system-based practice, professionalism, and practice-based learning and improvement) and converted them into an electronic Delphi questionnaire using Qualtrics software (SAP, Provo, UT, USA). We piloted the questionnaire at a single institution to refine the survey tool and assess for feasibility before disseminating it to the expert panel.

Setting and participants

We sent the survey to all 16 members of the education committee of the Society for Obstetric Anesthesia and Perinatology who were deemed experts in the field in obstetric anesthesiology education. The expert panel consisted of obstetric anesthesiologists with more than five years' experience in clinical practice, most of whom were fellowship-trained and/or held leadership positions at their academic institutions such as residency program director, obstetric anesthesia fellowship director, and chief of the obstetric anesthesia division. They represented centres with > 2,500 deliveries per year from five regions of the USA (West, Southwest, Midwest, Southeast and Northeast). One of the coauthors (M. P.-S.) is a member on the committee but did not participate in the Delphi survey because of her role as a coinvestigator.

Delphi process

The Delphi process was conducted rigorously using best practice guidelines.¹⁴ The data were collected from March to September of 2021. The Delphi process was conducted in two rounds. An invitation letter and link to the anonymous Delphi questionnaire was emailed to 16 experts on our Delphi panel.

For each round, the link remained open for four weeks with a reminder email sent at two weeks. In the first round, the respondents were asked about their level of experience and the birth volume at their institutions. They were also asked to evaluate the importance of each competency using a five-point Likert scale (5 = extremely important; 4 = very important; 3 = moderately important; 2 = slightly important; 1 = not at all important). The respondents were invited to provide feedback regarding omission, addition, or modification of the items on the questionnaire. In the second round, the modified questionnaire was repeated, and respondents were given the aggregate results from the first round. For each competency, the respondents were informed about the prior agreement level (80–100%; 60–79%; below 60%) that the competency was deemed “extremely important” or “very important”. The survey also included information regarding the consensus criteria for inclusion in the final list of competencies (i.e., 80% or more of respondents rating a competency as ≥ 4 (very or extremely important) after two rounds).

In the third round of survey, the final list of competencies was distributed asking the respondents to decide whether a competency should be attained at a junior or a senior resident level. The definitions of the terms were provided to the respondents. They were contextualized to the ACGME anesthesia residency training programs in the USA, which are three years in duration with an average of 2.7 months dedicated to obstetric anesthesia training. A junior resident is defined as a first- or second-year resident with four or fewer cumulative weeks experience on an obstetric anesthesia service and a senior resident is a second- or third-year resident with greater than four cumulative weeks experience on the service. A competency is achieved when the task can be completed by the resident with distant supervision (faculty available if needed) or indirect supervision (faculty directs the resident from time to time). The categorization of a junior vs senior level competency was determined by the majority of the votes from the respondents (i.e., > 50%).

Statistical analysis

In our study, we defined consensus as 80% or more of respondents rating a competency as ≥ 4 (very or extremely important) after two rounds. A > 70% level of agreement has been considered appropriate in previous Delphi studies.⁷ A mean score with standard deviation for level of importance was calculated for each competency and the level of agreement was analyzed as a percentage of the total number of respondents. All analyses were conducted using Qualtrics software (SAP, Provo, UT, USA) and IBM SPSS for Windows version 24 (IBM Corp., Armonk, NY, USA). We analyzed demographic data and questionnaire responses with descriptive statistical methods.

Results

A total of 12 (75%) anesthesiologists completed the survey for both rounds. A third separate round inquiring the level at which the competencies should be attained yielded a response rate of 9/16 (56%). Detailed demographics of the expert panel are shown in Table 1.

The final consensus list comprised 94 obstetric anesthesia residency competencies categorized under the six ACGME domains: patient care ($n = 38$, 40%), medical knowledge ($n = 45$, 48%), system-based practice ($n = 2$, 2%), practiced learning and improvement ($n = 5$, 5%), professionalism ($n = 2$, 2%), and interpersonal communication ($n = 2$, 2%) (Tables 2, 3, 4, 5).

Seven new competencies were suggested by the respondents, four of which were included in the final list. These included: 1) “Demonstrate ability to evaluate and manage breakthrough pain during Cesarean delivery;” 2) “Discuss common anesthetic/analgesic drugs that may enter breast milk and potentially cause harm to the newborn;” 3) “Demonstrate familiarity with institutional Enhanced Recovery After Surgery guidelines for Cesarean

delivery and bundles of maternal care;” and, 4) “Discuss how to mobilize additional resources during a crisis such as Massive Transfusion Protocol.”

The third round of survey had a less than adequate sample size ($N = 9$) to provide definitive results. Our expert panel felt 59 should be attained at a junior residency level (Tables 2–4) and 35 at a senior residency level (Table 5).

A total of 17 competencies did not meet the 80% consensus cut-off and were removed from the final list. Nine competencies were deemed “very” or “extremely” important by less than 60% of the respondents and eight competencies fell between the 60–80% consensus rate (Table 6). Of the eliminated competencies, 6/17 (35%) were associated with neonatal physiology and care.

Discussion

Through a Delphi methodology, our study has derived a list of core competencies for obstetric anesthesia residency

Table 1 Demographics of expert panel

Demographic	
Female, n /total N (%)	8/12 (67%)
Fellowship trained, n /total N (%)	10/12 (83%)
Academic centre, n /total N (%)	12/12 (100%)
Percentage of time in obstetric anesthesiology (%), median [IQR]	66 [50–80]
Number of years on SOAP education committee, median [IQR]	5 [4–7]
Residency education leadership roles, n /total N (%)	8/12 (67%)
Residency program director	4/12 (33%)
Clinical Competency Committee (ACGME)	1/12 (8%)
Vice chair of residency education	1/12 (8%)
Director of simulation and education for anesthesia	1/12 (8%)
Director of POCUS education	1/12 (8%)
Obstetric anesthesiology leadership roles, n /total N (%)	10/12 (83%)
Fellowship program director	4/12 (33%)
Chief of division	3/12 (25%)
Clinical director	3/12 (25%)
Director of obstetric anesthesiology research	2/12 (17%)
Years of obstetric anesthesia practice post residency, n /total N (%)	
6–10 years	4/12 (33%)
11–15 years	3/12 (25%)
> 15 years	5/12 (42%)
Number of deliveries at primary institution per annum, n /total N (%)	
2,500–4,999	7/12 (58%)
5,000–7,500	3/12 (25%)
> 7,500	2/12 (17%)

ACGME = Accreditation Council for Graduate Medical Education; IQR = interquartile range; POCUS = point-of-care ultrasound; SOAP = Society for Obstetric Anesthesia and Perinatology

Table 2 Obstetric anesthesia competencies for the junior residency level under the “patient care” ACGME domain

Essential competencies	Mean score (SD)	No. of respondents rating ≥ 4 n/total N (%)
Patient care		
Perform a focused history and physical examination relevant to a pregnant patient	4.8 (0.4)	12/12 (100%)
Explain the risks, benefits, and alternatives of labour epidural analgesia	4.8 (0.5)	12/12 (100%)
Explain the risks, benefits, and alternatives of neuraxial anesthesia for Cesarean delivery	4.8 (0.5)	12/12 (100%)
Discuss the risks and anesthetic implications of the following condition: breech	4.2 (0.7)	10/12 (83%)
Discuss the risks and anesthetic implications of the following condition: gestational thrombocytopenia	4.6 (0.5)	12/12 (100%)
Discuss the risks and anesthetic implications of the following condition: multiple gestation	4.3 (0.7)	11/12 (92%)
Discuss the risks and anesthetic implications of the following condition: trial of labour after Cesarean delivery	4.5 (0.5)	12/12 (100%)
Discuss the risks and anesthetic implications of the following condition: assisted vaginal birth	4.3 (0.8)	10/12 (83%)
Discuss the risks and anesthetic implications of the following condition: scoliosis and previous spine surgery	4.4 (0.5)	12/12 (100%)
Demonstrate the ability to make a patient appropriate choice of anesthesia/analgesia for: labour (spinal, CSE, DPE, epidural, nonneuraxial)	4.8 (0.4)	12/12 (100%)
Demonstrate the ability to make a patient appropriate choice of anesthesia/analgesia for: Cesarean delivery	4.8 (0.4)	12/12 (100%)
Demonstrate the ability to make a patient appropriate choice of anesthesia/analgesia for: postpartum tubal ligation	4.0 (1.1)	10/12 (83%)
Demonstrate the ability to make a patient appropriate choice of anesthesia/analgesia for: cervical cerclage	4.3 (0.7)	11/12 (92%)
Demonstrate the ability to make a patient appropriate choice of anesthesia/analgesia for: forceps- or vacuum-assisted vaginal delivery	4.4 (0.5)	12/12 (100%)
<i>Technical skills</i>		
Demonstrate techniques used to avoid aortocaval compression	4.4 (0.7)	11/12 (92%)
Demonstrate sterile and safe technique when preparing and administering neuraxial analgesia/anesthesia	4.9 (0.3)	12/12 (100%)
Demonstrate the ability to provide safe airway management for a pregnant patient	4.9 (0.3)	12/12 (100%)
Demonstrate successful placement of neuraxial anesthesia on patient with normal spinal anatomy and easily identifiable anatomical landmarks	4.8 (0.4)	12/12 (100%)
<i>Conduct of anesthesia</i>		
Demonstrate preparation and set-up of operating room for Cesarean delivery (medication, equipment)	4.8 (0.5)	12/12 (100%)
Demonstrate the ability to anticipate, prepare for, and treat common neuraxial-induced side effects (e.g., hypotension)	4.9 (0.3)	12/12 (100%)
Demonstrate the ability to convert epidural analgesia to epidural anesthesia for surgical intervention	4.9 (0.3)	12/12 (100%)
Demonstrate the ability to evaluate adequacy of neuraxial anesthesia for Cesarean delivery	4.9 (0.3)	12/12 (100%)
Demonstrate safe and effective management of postdelivery pain relief (i.e., neuraxial opioids, multimodal analgesia as per ERAS pathway)	4.5 (0.5)	12/12 (100%)
Demonstrate the ability to provide safe general anesthesia for Cesarean delivery	4.9 (0.3)	12/12 (100%)
Demonstrate ability to appropriately evaluate and manage breakthrough pain with labour epidural	4.7 (0.5)	12/12 (100%)
Demonstrate ability to evaluate and manage breakthrough pain during Cesarean delivery*	4.7 (0.5)	12/12 (100%)
<i>Crisis management</i>		
Demonstrate ability to manage postpartum hemorrhage	5.0 (0.0)	12/12 (100%)

Data are presented as mean values of ratings on a five-point Likert scale, where 5 indicates extremely important and 1 indicates not at all important. Level of agreement is presented as the number of respondents (%) who rated the competency 4 or 5.

*New competency suggested by respondents

ACGME = Accreditation Council for Graduate Medical Education; CSE = combined spinal epidural; DPE = dural puncture epidural; ERAS = enhanced recovery after surgery; SD = standard deviation

Table 3 Obstetric anesthesia competencies for the junior residency level under the “medical knowledge” ACGME domain

Essential competencies	Mean score (SD)	No. of respondents rating ≥ 4 n/total N (%)
Medical knowledge		
<i>Maternal physiology</i>		
Describe by system the physiology related to pregnancy and labour	4.8 (0.5)	12/12 (100%)
Outline changes and reference ranges for physiologic and biochemical variables in pregnancy	4.3 (1.0)	10/12 (83%)
Describe the maternal airway anatomy and the impact on airway management	4.7 (0.5)	12/12 (100%)
Describe stages of normal labour	4.3 (0.8)	10/12 (83%)
Describe physiology and nerve roots associated with labour pain	4.4 (0.5)	12/12 (100%)
<i>Neonatal physiology</i>		
Describe utero-placental circulation and physiology	4.1 (0.7)	10/12 (83%)
<i>Maternal comorbidities</i>		
Pre-eclampsia, HELLP Syndrome	5.0 (0.0)	12/12 (100%)
Morbid obesity	4.9 (0.3)	12/12 (100%)
Coagulation disorders	4.8 (0.4)	12/12 (100%)
<i>Pharmacology</i>		
Discuss local anesthetic pharmacology and their differences as they pertain to neuraxial anesthesia	4.8 (0.6)	11/12 (92%)
Discuss opioid pharmacology (including remifentanyl) and safe administration relevant to obstetric anesthesia	4.8 (0.5)	12/12 (100%)
Explain factors that influence transfer of drugs across the placenta	4.4 (0.8)	10/12 (83%)
Describe the pharmacology of oxytocic agents—oxytocin derivatives, ergot derivatives, prostaglandins	4.8 (0.5)	12/12 (100%)
Describe the pharmacology of tocolytic agents—beta 2 agonists, calcium antagonists, magnesium, inhalational anesthetics, nitrates	4.7 (0.5)	12/12 (100%)
Describe the pharmacology of agents used for treatment of pre-eclampsia, including magnesium, hydralazine, and labetalol	4.7 (0.5)	12/12 (100%)
Describe the pharmacology of tranexamic acid	4.3 (0.7)	11/12 (92%)
<i>Conduct of anesthesia</i>		
Describe the grading of urgency of Cesarean delivery	4.5 (0.7)	11/12 (92%)
Describe goals and principles of general anesthesia for Cesarean delivery	4.8 (0.4)	12/12 (100%)
Explain local fasting policies and aspiration prophylaxis in a pregnant patient undergoing surgery and after labour epidural placement	4.3 (0.7)	11/12 (92%)
Describe epidural, DPE, CSE, spinal analgesia in labour and discuss the indications, contraindications, and complications	4.5 (0.5)	12/12 (100%)
Describe the immediate management of accidental dural puncture	4.8 (0.5)	12/12 (100%)
Discuss diagnosis of postdural puncture headache	4.9 (0.3)	12/12 (100%)
Discuss management of postdural puncture headache including epidural blood patch	4.8 (0.4)	12/12 (100%)
<i>Crisis management</i>		
Describe risk factors and diagnosis of postpartum hemorrhage	4.8 (0.5)	12/12 (100%)
Discuss intrauterine resuscitation of the fetus at risk	4.8 (0.4)	12/12 (100%)
Local anesthetic systemic toxicity	4.8 (0.4)	12/12 (100%)
High/total neuraxial anesthetic	5.0 (0.0)	12/12 (100%)
Massive hemorrhage	5.0 (0.0)	12/12 (100%)

Data are presented as mean values of ratings on a five-point Likert scale, where 5 indicates extremely important and 1 indicates not at all important. Level of agreement is presented as the number of respondents (%) who rated the competency 4 or 5.

ACGME = Accreditation Council for Graduate Medical Education; CSE = combined spinal epidural; DPE = dural puncture epidural; HELLP = hemolysis, elevated liver enzymes and low platelets; SD = standard deviation

Table 4 Obstetric anesthesia competencies for the junior residency level under the “practice-based learning and improvement”, “professionalism” and “communication” ACGME domains

Essential competencies	Mean score (SD)	No. of respondents rating ≥ 4 n/total N (%)
Practice-based learning and improvement		
Perform routine follow up evaluation of obstetric patient following anesthetic intervention	4.7 (0.5)	12/12 (100%)
Demonstrate familiarity with institutional ERAS guidelines for Cesarean delivery and bundles of maternal care*	4.3 (0.9)	11/12 (92%)
Interpersonal communication		
Establish rapport and trust with the patient and develop a shared anesthesia plan for labour and birth	4.9 (0.3)	12/12 (100%)
Professionalism		
Understand and respect the roles and responsibilities of midwives and labour and delivery nurses	4.1 (0.7)	10/12/ (83%)
Demonstrate culturally competent, family-centred care that is respectful towards a patient’s phase of care and medical literacy	4.8 (0.5)	12/12 (100%)

Data are presented as mean values of ratings on a five-point Likert scale, where 5 indicates extremely important and 1 indicates not at all important. Level of agreement is presented as the number of respondents (%) who rated the competency 4 or 5.

*New competency suggested by respondents

ERAS = enhanced recovery after surgery; SD = standard deviation

training in the USA. The majority of the competencies are consistent with those found in other established CBME programs, albeit categorized under different taxonomies that are specific to the individual medical education systems (e.g., the ACGME six core domains in the USA vs the CanMEDS seven core roles in Canada).^{5,15} The Delphi process allowed us to identify competencies that reflect current and emerging trend in obstetric anesthesia practice such as the application of the Enhanced Recovery After Cesarean guidelines.¹⁶

Despite being included in the ABA Initial Certification content, many competencies that did not meet the consensus criterion among our panel experts were associated with neonatal physiology and care (e.g., Rhesus isoimmunization, calculation of Apgar score, umbilical cord blood gas analysis, and neonatal resuscitation) (Table 6). In contrast, these competencies were included as part of core knowledge in other CBME programs and may reflect the broader scope of practice for anesthesiologists in other countries. A study has shown that the probability of an anesthesiologist’s involvement in newborn resuscitation is inversely proportional to the birth volume of the institution and has been reported to be as high as 65%.¹⁷ The result may also reflect the perspectives of the expert panel who practice in large nonrural academic centres, where specialized personnel to resuscitate the newborn are readily available.

Another discordant finding compared with other CBME curricula is that the understanding of use of nitrous oxide for labour analgesia did not meet the consensus cut-off. Despite its long safety record of use in pregnancy, access to

nitrous oxide for labour analgesia remains limited and its use in the USA is not widespread, compared with other western countries (e.g., Canada, UK, Scandinavia, Australia).^{18,19} This may explain why this competency was deemed unimportant or irrelevant in this context. The uptake of its use has increased in many birthing centres in the past decade, which may lead to a change in practice in the USA over time and impact competency training of anesthesia residents.¹⁸ Demonstrating the ability to make a patient-appropriate choice of anesthesia/analgesia for dilation and curettage/evacuation also did not meet the consensus cut-off. This may be explained by the differences in service structures of many institutions, where these procedures especially for early pregnancy cases, are likely performed in the main operating rooms under gynecology service and not on the labour unit. The result may have been different had the competency been specifically defined as postpartum dilation and curettage.

Anesthesia residency duration and training structure vary greatly between countries, ranging from three years in the USA to five years in Canada and nine years in the UK.²⁰ The minimum rotation requirement for obstetric anesthesia as set out by the ACGME is two months but this can vary between institutions.⁶ To make the competencies operational and easily adaptable to different training programs in the USA, we have defined the expected level of competencies as junior and senior with the former being defined as less than four weeks of cumulative obstetric anesthesia experience and the latter being greater than four weeks.

Table 5 Obstetric anesthesia competencies for the senior residency level

Essential competencies	Mean score (SD)	No. of respondents rating ≥ 4 n/total N (%)
Patient care		
Discuss the risks and anesthetic implications of the following condition: abnormal placentation (previa, vasa previa, accreta, increta, percreta)	4.8 (0.4)	12/12 (100%)
Discuss the risks and anesthetic implications of the following condition: cord prolapse	4.8 (0.5)	12/12 (100%)
Discuss the risks and anesthetic implications of the following condition: uterine rupture	4.8 (0.5)	12/12 (100%)
Discuss the risks and anesthetic implications of the following condition: placental abruption	4.5 (0.7)	11/12 (92%)
Discuss the risks and anesthetic implications of the following condition: shoulder dystocia	4.5 (0.7)	11/12 (92%)
Discuss the risks and anesthetic implications of the following condition: retained placenta	4.6 (0.5)	12/12 (100%)
Discuss the risks and anesthetic implications of the following condition: external cephalic version	4.6 (0.5)	12/12 (100%)
<i>Technical skills</i>		
Demonstrate successful placement of neuraxial anesthesia on patient with abnormal spinal anatomy and/or without easily identifiable anatomical landmarks	4.9 (0.3)	12/12 (100%)
<i>Conduct of anesthesia</i>		
Demonstrate ability to manage Cesarean delivery for abnormal placentation	4.9 (0.3)	12/12 (100%)
<i>Crisis management</i>		
Demonstrate ability to manage eclampsia	4.6 (0.7)	11/12 (92%)
Medical knowledge		
<i>Maternal physiology</i>		
Describe the risk factors for and types of abnormal placentation	4.4 (0.5)	12/12 (100%)
<i>Maternal comorbidities</i>		
Discuss the pathophysiology and anesthetic management of the following maternal condition: peripartum cardiomyopathy	4.8 (0.4)	12/12 (100%)
Discuss the pathophysiology and anesthetic management of the following maternal condition: valvular disease	4.7 (0.7)	11/12 (92%)
Discuss the pathophysiology and anesthetic management of the following maternal condition: cardiomyopathy	4.8 (0.5)	12/12 (100%)
Discuss the pathophysiology and anesthetic management of the following maternal condition: substance use	4.5 (0.7)	11/12 (92%)
<i>Pharmacology</i>		
Discuss common anesthetic/analgesic drugs that may enter breast milk and potentially cause harm to the newborn*†	4.11 (1.1)	8/9 (89%)
Demonstrate knowledge of ACOG guidelines on antibiotic prophylaxis for Cesarean delivery*	4.3 (0.8)	10/12 (83%)
<i>Conduct of anesthesia</i>		
Explain the timing of common antithrombotics and neuraxial placement/catheter removal	4.7 (0.5)	12/12 (100%)
Describe how to assess neurologic complication in the postpartum period	4.7 (0.5)	12/12 (100%)
Discuss management of anesthesia for the pregnant woman having nonobstetric surgery	4.7 (0.5)	12/12 (100%)
Explain how to assess fetal wellbeing through basic interpretation of the fetal cardiotocography	4.2 (0.6)	11/12 (92%)
<i>Crisis management</i>		
Discuss management of postpartum hemorrhage including triggers for activating and deactivating massive transfusion protocol and role of fibrinogen in PPH treatment	4.9 (0.3)	12/12 (100%)
Describe maternal ACLS and indications for perimortem Cesarean delivery	4.9 (0.3)	12/12 (100%)
Describe management and resuscitation of the pregnant trauma patients	4.5 (0.7)	11/12 (92%)
Discuss diagnosis and management of: Amniotic fluid embolus	4.8 (0.5)	12/12 (100%)
Discuss diagnosis and management of: thromboembolism	4.7 (0.5)	12/12 (100%)
Discuss diagnosis and management of: eclampsia	4.9 (0.3)	12/12 (100%)
Discuss diagnosis and management of: magnesium toxicity	4.8 (0.4)	12/12 (100%)

Table 5 continued

Essential competencies	Mean score (SD)	No. of respondents rating ≥ 4 <i>n</i> /total <i>N</i> (%)
System-based practice		
Outline the main causes of maternal mortality in the USA and in the global context	4.3 (0.5)	12/12 (100%)
Discuss the causes and impact of racial and ethnic disparities and health inequity in obstetrics and gynecology and proposed solutions by professional bodies (e.g., ACOG) to overcome this	4.4 (0.7)	11/12 (92%)
Practice-based learning and improvement		
Coordinate patient care with other team members on the labour and delivery suite	4.8 (0.5)	12/12 (100%)
Prioritize care appropriately when caring for multiple obstetric patients	4.7 (0.5)	12/12 (100%)
Discuss how to mobilize additional resources during a crisis such as massive transfusion protocol*	4.6 (0.5)	12/12 (100%)
Interpersonal communication		
Actively participate in planning and coordination of care for a complex obstetric patient within a multidisciplinary team	4.8 (0.4)	12/12 (100%)

Data are presented as mean values of ratings on a five-point Likert scale, where 5 indicates extremely important and 1 indicates not at all important. Level of agreement is presented as the number of respondents (%) who rated the competency 4 or 5.

[†]*N* = 9

*New competencies suggested by respondents

ACLS = advanced cardiovascular life support; ACOG = American College of Obstetricians and Gynecologists; PPH = postpartum hemorrhage; SD = standard deviation

Of the 94 competencies, almost half ($n = 45$, 48%) are knowledge based and can be matched to the appropriate education strategies.²¹ For instance, didactic lectures can be used to explain main concepts in obstetric anesthesia, short case-based learning tutorials for complex maternal conditions can be taught on the floor, while on-service and simulation may be used to teach crisis management and communication competencies. Depending on the education structure for individual residency programs, some teaching sessions (e.g., lecture, simulation) can be integrated longitudinally into the curriculum and not only be taught during the obstetric anesthesia placement. Each teaching session can also cover more than one competency if there are overlapping themes (e.g., trial of labour after Cesarean delivery and uterus rupture). Furthermore, many knowledge-based competencies can be achieved through asynchronous self-directed learning by the residents, with appropriate resource guidance provided by the faculty. In this way, the limited clinical rotation time can be maximized to teach competencies that fall under “patient care,” “system-based practice,” “practice-based learning and improvement,” and “professionalism.”

Our study has several implications for curriculum development in obstetric anesthesia residency training in the USA. The ACGME anesthesiology milestones have provided a general framework for assessment of the development of the resident in key competency areas, which can be applied to different subspecialties.²² Although a more specific framework has been developed for obstetric anesthesiology at a fellowship level, such

guidance does not exist at a residency level.²³ The granularity of our competency list broken down into junior and senior levels allows for it to be easily mapped to this milestones framework. The competencies can also be reconceptualized into entrustable professional activities, a workplace-based evaluation method that is rapidly gaining popularity and wide adoption in modern CBME programs.²⁴ The list can help faculty plan education strategies to target specific competencies, identify specific gaps in training, and balance the education and service needs for individual residents, all of which may lead to improved quality and experience of training.²⁵

Our study had a small sample size although the number falls within an acceptable range for a Delphi study. More importantly, we wanted to get consensus from a group that has expertise in the subject matter and that represented viewpoints from multiple institutions with good geographical spread within the USA. We were able to achieve this with a good response rate of 75% for both rounds. Getting true expert opinion and sustained survey commitment from participants have been argued to be more important than sample size.²⁶ A limitation in our study is that the expert panel composed of obstetric anesthesiologists from large academic centres whose opinions may not reflect the practice of those working in smaller rural centres. The third round of survey regarding the junior and senior level categorization had less than adequate sample size and the survey was not repeated, so these results do not reflect expert consensus. Acknowledging the wide variability in the training

Table 6 List of competencies that did not meet the consensus criteria after two rounds of survey

	Mean score (SD)	No. of respondents rating ≥ 4 <i>n</i> /total <i>N</i> (%)
<i>Competencies with 60–79% consensus</i>		
Patient care		
Discuss the risks and anesthetic implications of chorioamnionitis	4.17 (0.8)	9/12 (75%)
Discuss the risks and anesthetic implications of fetal demise <i>in utero</i>	4.0 (0.9)	8/12 (67%)
Demonstrate the ability to make a patient appropriate choice of anesthesia/analgesia for dilation and curettage/evacuation	4.0 (0.9)	8/12 (67%)
Demonstrate ability to use point-of-care ultrasound to evaluate lumbar spine for neuraxial placement* [†]	3.9 (0.6)	7/9 (78%)
Demonstrate ability to use an early warning score system to identify patients at higher risk of morbidity/mortality	3.8 (1.2)	8/12 (67%)
Medical knowledge		
Discuss use of point-of-care coagulation testing (TEG, ROTEM) in acute management of the bleeding parturient*	3.9 (0.9)	9/12 (75%)
Describe basic neonatal resuscitation	3.9 (0.7)	9/12 (75%)
Professionalism		
Demonstrate ability to recognize and respect maternal and neonatal privacy	3.9 (1.2)	9/12 (75%)
<i>Competencies with < 60% consensus</i>		
Patient care		
Discuss the risks and anesthetic implications of preterm labour and postdates parturient	3.5 (0.8)	6/12 (50%)
Medical knowledge		
Describe how to calculate the Apgar score	3.3 (0.9)	5/12 (42%)
Describe the transition from fetal to neonatal circulation and establishment of ventilation	3.3 (1.0)	4/12 (33%)
Describe normal neonatal blood gas values	3.3 (1.0)	4/12 (33%)
Discuss the pathophysiology and anesthetic management of psychiatric conditions	3.7 (0.9)	7/12 (58%)
Discuss the pathophysiology and anesthetic management of rhesus isoimmunization	3.4 (0.7)	6/12 (50%)
Describe the concept of ion trapping in fetal pharmacology	3.4 (0.9)	6/12 (50%)
Describe the pharmacology of nitrous oxide used for labour analgesia	3.2 (0.9)	5/12 (42%)
Discuss pharmacologic management of shivering in the parturient who has received neuraxial analgesia/anesthesia [†]	3.4 (0.7)	5/9 (56%)

The list is broken down into competencies with 60–79% and those with < 60% of respondents rating them 4 or 5 on a five-point Likert scale. Data are presented as mean values of ratings on a five-point Likert scale, where 5 indicates extremely important and 1 indicates not at all important. Level of agreement is presented as the number of respondents (%) who rated the competency 4 or 5.

[†]*N* = 9

*New competency suggested by respondents

APGAR = appearance, pulse, grimace, activity, and respiration; ROTEM = rotational thromboelastometry; SD = standard deviation; TEG = thromboelastography

program structure within the USA, our aim was not to derive expert recommendations regarding specific milestones, but rather to provide a guide that can be easily adapted to different institutions. Lastly, our findings are specific to obstetric anesthesia practice within the USA and so may need to be modified before extrapolating to other contexts.

Conclusions

Given the comparatively short duration of training and time spent within a subspecialty, there is a need for a more defined competency-based curriculum to maximize the quality and efficiency of anesthesia residency training programs in the USA. This study used an expert consensus approach to establish core resident competencies for obstetric anesthesiology. This list can be used by residency training programs to help plan targeted education strategies and to guide ACGME milestones

mapping and evaluation methods to assess attainment of the competencies in obstetric anesthesiology.

Author contributions *Maytinee Lilaonitkul* contributed to all aspects of this manuscript, including study conception and design; acquisition, analysis, and interpretation of data; and drafting the article. *Christopher W. Cosden* contributed to study design; acquisition, analysis, and interpretation of data; and drafting the article. *John C. Markley* contributed to study design, interpretation of data, and drafting the article. *May Pian-Smith* contributed to interpretation of data and drafting the article. *Grace Lim* contributed to interpretation of data and drafting the article. *Peter Yeh* contributed to interpretation of data and drafting the article. *Pedram Aleshi* contributed to interpretation of data and drafting the article. *Christy Boscardin* contributed to design; analysis, and interpretation of data and drafting the article. *Kristina Sullivan* contributed to interpretation of data and drafting the article. *Ronald B. George* contributed to study conception and design, interpretation of data, and drafting the article.

Disclosures Dr. George is a consultant for an Octapharma USA, Inc. Advisory Board and an Associate Editor of the *Canadian Journal of Anesthesia Journal canadien d'anesthésie*; he had no involvement in the handling of this manuscript. Dr Lim is supported by the NIH (UH3CA261067, R41DA053877) and Huron Therapeutics, and receives support in kind or consultative stipends from Masimo and Octapharma.

Funding statement None.

Prior conference presentations Abstract presentation at the Society for Obstetric Anesthesia and Perinatology 54th Annual Meeting (11–15 May 2022, Chicago, IL, USA).

Editorial responsibility This submission was handled by Dr. Stephan K. W. Schwarz, Editor-in-Chief, *Canadian Journal of Anesthesia/Journal canadien d'anesthésie*.

Open Access This article is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License, which permits any non-commercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc/4.0/>.

References

1. Osterman MJ, Hamilton BE, Martin JA, Driscoll AK, Valenzuela CP, Division of Vital Statistics. Births: final data for 2020. *NVSS* 2022; 70: 1–50. Available from <https://www.cdc.gov/nchs/data/nvsr/nvsr70/nvsr70-17.pdf> (accessed March 2023).
2. *Review to Action*. Report from nine maternal mortality review committees. Available from URL: <https://reviewtoaction.org/national-resource/report-nine-mmrcs> (accessed March 2023).
3. Lockyer J, Carraccio C, Chan MK, et al. Core principles of assessment in competency-based medical education. *Med Teach* 2017; 39: 609–16. <https://doi.org/10.1080/0142159x.2017.1315082>
4. Hawkins R, Welcher C, Holmboe ES, et al. Implementation of competency-based medical education: are we addressing the concerns and challenges? *Med Educ* 2015; 49: 1086–102. <https://doi.org/10.1111/medu.12831>
5. Swing SR. The ACGME outcome project: retrospective and prospective. *Med Teach* 2007; 29: 648–54. <https://doi.org/10.1080/01421590701392903>
6. Panni MK, Camann WR, Tsen LC. Resident training in obstetric anesthesia in the United States. *Int J Obstet Anesth* 2006; 15: 284–9. <https://doi.org/10.1016/j.ijoa.2006.04.013>
7. Ende HB, Lozada MJ, Micevych PS, et al. A survey of USA anesthesiology residents regarding their perceptions of, and barriers to, fellowship training in obstetric anesthesia. *Int J Obstet Anesth* 2021; 46: 103159. <https://doi.org/10.1016/j.ijoa.2021.103159>
8. Shorten GD, De Robertis E, Goldik Z, Kietaibl S, Niemi-Murolo L, Sabelnikovs O. European Section/Board of Anaesthesiology/European Society of Anaesthesiology consensus statement on competency-based education and training in anaesthesiology. *Eur J Anaesthesiol* 2020; 37: 421–34. <https://doi.org/10.1097/eja.0000000000001201>
9. *The Royal College of Physicians and Surgeons of Canada*. National curriculum for Canadian anesthesiology residency. Available from URL: <https://www.royalcollege.ca/rcsite/documents/ibd/anesthesiology-national-curriculum-e.pdf> (accessed March 2023).
10. *The Royal College of Physicians and Surgeons of Canada*. Entrustable professional activities for Anesthesiology, 2019. Available from <https://www.royalcollege.ca/rcsite/documents/cbd/epa-guide-anesthesiology-v3-e.pdf> (accessed March 2023).
11. *The Royal College of Anaesthetists*. CCT in anaesthetics - core level training, 2019. Available from URL: <https://rcoa.ac.uk/documents/cct-anaesthetics-core-level-training/obstetrics> (accessed March 2023).
12. *The Australian and New Zealand College of Anaesthetists*. Anaesthesia training program curriculum, 2022. Available from URL: <https://www.anzca.edu.au/resources/all-handbooks-and-curriculums/anzca-anaesthesia-training-program-curriculum> (accessed March 2023).
13. *The American Board of Anesthesiology*. Initial certification in anesthesiology, 2022. Available from URL: https://theaba.org/pdfs/Initial_Certification_Content_Outline.pdf (accessed March 2023).
14. Humphrey-Murto S, Varpio L, Gonsalves C, Wood TJ. Using consensus group methods such as Delphi and Nominal Group in medical education research. *Med Teach* 2017; 39: 14–9. <https://doi.org/10.1080/0142159x.2017.1245856>
15. Frank JR, Danoff D. The CanMEDS initiative: implementing an outcomes-based framework of physician competencies. *Med Teach* 2007; 29: 642–7. <https://doi.org/10.1080/01421590701746983>
16. Bollag L, Lim G, Sultan P, et al. Society for Obstetric Anesthesia and Perinatology: Consensus Statement and Recommendations for Enhanced Recovery After Cesarean. *Anesth Analg* 2021; 132: 1362–77. <https://doi.org/10.1213/ane.0000000000005257>
17. Gaiser R, Lewin SB, Cheek TG, Gutsche BB. Anesthesiologists' interest in neonatal resuscitation certification. *J Clin Anesth* 2001; 13: 374–6. [https://doi.org/10.1016/s0952-8180\(01\)00285-9](https://doi.org/10.1016/s0952-8180(01)00285-9)
18. Richardson MG, Lopez BM, Baysinger CL. Should nitrous oxide be used for laboring patients? *Anesthesiol Clin* 2017; 35: 125–43. <https://doi.org/10.1016/j.anclin.2016.09.011>

19. Collins MR, Starr SA, Bishop JT, Baysinger CL. Nitrous oxide for labor analgesia: expanding analgesic options for women in the United States. *Rev Obstet Gynecol* 2012; 5: e126–31.
20. Yamamoto S, Tanaka P, Madsen MV, Macario A. Comparing anesthesiology residency training structure and requirements in seven different countries on three continents. *Cureus* 2017; 9: e1060. <https://doi.org/10.7759/cureus.1060>
21. *MedBiquitous*. Curriculum data exchange: curriculum inventory. Available from URL: <https://www.medbiq.org/standards/curriculum-inventory> (accessed March 2023).
22. Ambardekar AP, Walker KK, McKenzie-Brown AM, *et al.* The Anesthesiology Milestones 2.0: An Improved Competency-Based Assessment for Residency Training. *Anesth Analg* 2021; 133: 353–61. <https://doi.org/10.1213/ane.0000000000005499>
23. *The Accreditation Council for Graduate Medical Education*. Obstetric anesthesiology milestones, 2022. Available from URL: <https://www.acgme.org/globalassets/pdfs/milestones/obstetricanesthesiologymilestones.pdf> (accessed March 2023).
24. Woodworth GE, Marty AP, Tanaka PP, *et al.* Development and pilot testing of entrustable professional activities for US anesthesiology residency training. *Anesth Analg* 2021; 132: 1579–91. <https://doi.org/10.1213/ane.0000000000005434>
25. Sun H, Chen D, Warner DO, *et al.* Anesthesiology residents' experiences and perspectives of residency training. *Anesth Analg* 2021; 132: 1120–8. <https://doi.org/10.1213/ane.0000000000005316>
26. Humphrey-Murto S, Varpio L, Wood TJ, *et al.* The use of the Delphi and other consensus group methods in medical education research: a review. *Acad Med* 2017; 92: 1491–8. <https://doi.org/10.1097/acm.0000000000001812>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.