Brazilian Journal of Anesthesiology 2021;71(3):254–258

Sociedade Brasileira de Anestesiologia

Brazilian Journal of ANESTHESIOLOGY

CLINICAL RESEARCH

General anesthesia for emergency cesarean delivery: simulation-based evaluation of residents

Júlio Alberto Rodrigues Maldonado Teixeira *, Cláudia Alves, Conceição Martins, Joana Carvalhas, Margarida Pereira

Centro Hospitalar e Universitário de Coimbra, Serviço de Anestesiologia, Coimbra, Portugal

Received 15 January 2020; accepted 12 February 2021
Available online 30 April 2021

KEYWORDS
General anesthesia;
Emergency cesarean;
Simulation;
Resident evaluation

Abstract
Introduction: Decreased rates of General Anesthesia (GA) for Cesarean Section (C-section) create a learning problem for anesthesia trainees. In this context, training the management of GA for C-section using simulation techniques allows a safe environment for exposure, learning, performance improvement, and capability retention.
Objective: Analyze anesthesia residents' performance regarding a simulated clinical case of GA for emergency C-section and identify specific deficits in skill acquisition.
Methods: Between 2015 and 2018, we evaluated the performance of 25 anesthesiology residents challenged by a simulated clinical case of GA for emergency C-section after the conclusion of the obstetric anesthesia rotation. Each resident performed the clinical case once followed by the assessment of their performance. Final scores were given according to the completion rate of 14-tasks, going from 0% to 100%. Two study groups were considered according to residency year for subsequent comparison of results (Group 1, second and third residency years and Group 2, fourth and fifth residency years).
Results and discussion: Mean score was 64.29% ± 13.62. Comparatively, Group 1 obtained a higher score than Group 2 (70.63% ± 14.02 vs. 60.27% ± 11.94), although with no statistically significant difference (p = 0.063). The tasks most frequently accomplished were opioid administration (100%), rapid sequence technique (100%), pre-oxygenation (92%), gastric content aspiration prophylaxis (84%), and previous clinical history (84%). Conversely, the tasks less frequently accomplished were confirming presence of pediatrician (64%), oxytocin administration (56%), PONV prophylaxis (56%), and preoperative airway assessment (48%).
Conclusion: The performance of the residents observed in this study was comparable to results previously published. The final score did not depend on the residency year.

* Corresponding author.
E-mail: julio.rt.18@gmail.com (J.A. Teixeira).

https://doi.org/10.1016/j.bjane.2021.02.059

Introduction

C-Section delivery (CS) is one of the most frequently performed surgeries worldwide. There has been, in recent years, an increase in the cesarean rate and the trend for continuous growth in the future has been observed.[1] Simultaneously, a change in the anesthetic management for C-section has been observed favoring regional anesthesia techniques, with a significant decrease in General Anesthesia (GA) use, which has been used preponderantly for emergency CS.[2,3] Given the low frequency and complexity of obstetric emergencies and minimal exposure of anesthesiology residents to the GA technique for CS, major learning and performance deficits may occur in this specific area.[3,4]

Within this scenario, simulation training is particularly relevant as a learning tool,[3–5] and represents an alternative to provide clinical exposure to this scenario, without posing a risk to patient safety.[6,7] Simulation training enables active involvement of participants and contributes to fast forward acquisition of competences, improve long-term retention, and preclude loss of competences already acquired.[7,8] It also allows multidisciplinary training aimed at optimizing the efficiency of team work.[8]

There is evidence that critical event training using simulation improves performance of residents to deliver certain required tasks when faced with these critical events in clinical practice.[4,6,8] The simulation scenario of GA for emergency CS has been often used to improve individual technical capacities and non-technical capacities.[8]

Although there are several performance assessment tools for simulation not yet validated,[3,8] they are used to assess practice of anesthesiology residents, because they enable the identification of gaps in training and detect failure in critical competences, frequently not revealed by the classical assessment tools.[9]

The Centro Hospitalar e Universitário de Coimbra (CHUC) encompasses two maternities, Daniel de Matos (MDM) and Bissaya Barreto (MBB), and performs, on average, 4,500 deliveries a year, with a CS rate of approximately 27%. The mean GA rate for CS is 13%. Each resident performs, on average, 5 GA for CS during the rotation.

At this hospital center, for four years, one of the evaluation components of the obstetric anesthesia rotation was performed with a practical exam, solving two simulated clinical cases. All exams included a case of GA for emergency CS.

The primary objective of the present paper was to analyze the performance of anesthesiology residents on a clinical case of GA for emergency CS. The secondary objectives were the identification of specific deficiencies to acquire competences, and the possible relationship with the residency year (earlier or later) of the training program.

Methods

Based on an assessment table, we conducted a retrospective observational study to analyze the performance of 25 residents of anesthesiology on solving a simulation of a clinical case of general anesthesia for emergency C-section.

In Portugal, the anesthesiology training program lasts 5 years. Obstetric anesthesia training occurs after the second year of the program and lasts 3 to 4 months.

It was a convenience sample based on the rotation of anesthesiology residents at CHUC between the second and fifth years of residency, and who, between 2015 and 2018 concluded training in obstetric anesthesia. At the beginning of the training period, residents were informed about the evaluation method, and that the practice exam would be taken after concluding training. The clinical case was simultaneous for different year residents. Due to logistics and professional factors the participants, senior residents, had a longer gap between conclusion of obstetric rotation and the evaluation. Residents were familiar with the simulator and environment but were not aware of the clinical cases they would be involved with.

Simulated clinical cases were conducted at the Centro de Simulação Biomédica de Coimbra, recreating the environment of a surgical block, and using high-fidelity simulator SimMan (Laerdal, Wappingers Falls, NY, USA). The clinical case and respective assessment table were prepared by four instructors, anesthesiologists with experience in obstetrics and working regularly with clinical simulation. The design of the clinical case was based on simulation strategies previously published, adapted to the objectives of the proposed assessment.[3,4,9,10] The team of four instructors held all the simulation exams during the study period, alternating function of anesthesia nurse/actress, simulator operator and observer. Each resident took one individual exam and was assessed only once.

For each case, one of the instructors made a summary, supplying information on the clinical case, by reading a script to the resident who would be the anesthesiologist in charge. During the progression of the scenario, additional details were provided only upon resident request.

The obstetric case focused on the management of an emergency C-section due to acute fetal distress (cardiotocographic registration with multiple and prolonged deaccelerations with slow recovery and meconium in the amniotic fluid). The pregnant patient did not present criteria for difficult airway or co-morbidities. Patient refused neuraxial anesthesia. She was connected to a device registering the standard American Society of Anesthesiologists (ASA) monitoring parameters. The anesthesia nurse (actress) presented the scenario and informed that the obstetric team was present, prepared, and requesting to start the C-section as soon as possible. The scenario continued as if it were a GA for C-section in real-life, including pre-anesthesia assessment, choice of drugs, choice and preparation of intubation and ventilation material, integration into the dynamics of the team involved, and management of the clinical case.

Each case lasted approximately 10 to 15 minutes followed by debriefing with each resident that lasted 20 minutes, conducted by two instructors (operator and observer), based on registrations of the four instructors on the assessment table, comprising also the non-technical capacities revealed during the scenario.

The assessment table included 14 tasks. Each item was classified as ''completed'' and ''not completed''. The final score was calculated according to the percentage of tasks completed. At that time, due to the educational and training

Table 1 Accomplishment of pre-defined tasks by study groups.

Assessment table tasks	Group 1 (n = 9) % (n)	Group 2 (n = 16) % (n)
Pre-anesthetic evaluation		
Brief clinical history	77.8 (7)	87.5 (149)
Checking fasting	88.9 (8)	68.8 (11)
Pre-induction AW assessment	44.4 (4)	50 (8)
Checking AW material	66.7 (6)	81.3 (13)
Checking suction	66.7 (6)	75 (12)
Pulmonary gastric content aspiration prophylaxis	100 (9)	75 (12)
Presence of pediatrician	44.4 (4)	25 (4)
Anesthesia induction		
Lateral uterus displacement	88.9 (8)	56.3 (9)
Pre-oxygenation	100 (9)	87.5 (14)
Rapid sequence induction technique	100 (9)	100 (16)
Anesthesia maintenance		
Administration of opioid	100 (9)	100 (16)
Dosage of opioid (μg) (median)	100	100
Oxytocin	55.6 (5)	37.5 (6)
Early anesthesia recovery		
Post-operative analgesia	88.9 (9)	68.8 (11)
PONV prophylaxis	66.7 (6)	31.3 (5)
Mean score (mean ± SD)	**70.63%±14.04**	**60.27%±11.94**

AW, Airway; SD, Standard-Deviation; PONV, Postoperative Nausea and Vomit.

nature of the examination, no minimum classification score was established.

Statistical analysis was performed using SPSS® software v.23. All statistical calculations were done considering $p < 0.05$ as statistically significant.

The descriptive analysis presents categoric variables as frequencies and percentages, and continuous variables as means and standard deviations.

Two study group were considered, according to year of residency at the time the evaluation was performed. Group 1 included 2nd and 3rd year residents, and Group 2 included 4th and 5th-year residents. Means of group scores (continuous variables) were compared by the Student *t*-test. The comparison between the two groups for qualitative variables was checked by the Chi-Square test.

Results

Due to the dynamic and complex nature of the examination, it was not possible to, in some assessments, register ''completed/not completed'' for all tasks on the assessment table, having been registered as missing (total of 4). Statistical analysis was adjusted accordingly. As previously stated, we studied a convenience sample, therefore it was not homogeneous regarding year of residency, with 64% of the participants (n = 16) represented by 4th and 5th-year residents.

The performance of each task during the simulation scenario, is shown in Table 1 according to the group.

Considering a global classification of 100% to execute all tasks on the evaluation table, the total mean score attained was 64.29% ± 13.62, with a minimum of 43% and a maximum of 86%. Group 1 attained a mean score of 70.63% ± 14.04 while Group 2 showed a mean score of 60.27% ± 11.94. Despite the higher mean score of Group 1 versus Group 2, we observed no statistically significant difference ($p = 0.063$).

The median number of tasks completed was nine, seven of which were completed by over 75% of the residents. Items with a higher completion rate were administration of opioid (100%), rapid sequence induction technique (100%), pre-oxygenation (92%), prophylaxis of pulmonary aspiration of gastric content (84%) and obtaining patientś past medical history (84%). On the other hand, items with higher non-completion rates were confirmation of the presence of a pediatrician (64%), confirmation of administration of oxytocin after fetal extraction (56%), PONV prophylaxis (56%) and Airway (AW) assessment before induction (48%).

No significant statistical differences were observed between groups 1 and 2 in relation to the tasks more, and less frequently executed (Tables 2 and 3).

Concerning tasks related to AW management, verification of suction device operation, and checking and preparing airway material were carried out consistently (72% and 76%, respectively). Tasks related to airway equipment included checking the availability of face masks and Endotracheal Tubes (ETT) of several sizes, in addition to availability of difficult airway devices. As to the latter, there was great variability in individual choices, making the classification impossible. Fasting time was checked by 76% of residents. Positioning the patient with left uterine displacement was confirmed in 68% of cases.

Regarding induction drug choice, 68% opted for thiopental and 32% for propofol. For neuromuscular relaxation, 92% opted for suxametonium and 8% for rocuronium. The median dose of fentanyl administered was 100 μg in both groups, with a wide range between minimum, 50 μg, and maximum,

Table 2 Tasks with highest completion rate.

Assessment table tasks	Group 1 % (n)	Group 2 % (n)	*p*-value
Administration of opioid	100 (9)	100 (16)	[a]
Rapid sequence technique	100 (9)	100 (16)	[a]
Pre-oxygenation	100 (9)	87.5%	0.520
Gastric content suction prophylaxis	100 (9)	75.0 (12)	0.260
Brief clinical history	77.8 (7)	87.5 (14)	0.602

[a] Tasks with constant results, not enabling calculation of association measurement.

Table 3 Tasks not completed with highest rates.

Assessment table tasks	Group 1, % (n)	Group 2, % (n)	*p*-value
Presence of pediatrician	44.4 (4)	25.0 (4)	0.245
Oxytocin	55.6 (5)	37.5 (6)	0.434
Pre-induction AW assessment	44.4 (4)	50 (8)	0.616
PONV prophylaxis	66.7 (6)	31.3 (5)	0.115

250 μg. Postoperative analgesia therapy was established in 76% of cases.

Discussion

High-fidelity simulation training in obstetric anesthesia enhances the process of developing and retaining crucial competences by performing and repeating simulated clinical cases and also by detecting critical flaws during performance.[3] It equally allows improvement in clinical, behavioral and team work capacities,[11] contributing to enhancement of care provided to patients[3] and outcomes.[12] In past years, the use of this type of drill for the management of rare and complex scenarios in a simulation environment has grown.[4] Along the same line of progress, evaluating competences by means of simulation-based techniques has also been introduced.[13] For the latter, a real case-based scenario is desirable.[7] Simulation of GA for emergency CS has become increasingly important for training of anesthesiologists.[10] As an alternative method to classical recommended learning, it provides more exposure to the specificities of this scenario and safer performance training.[5]

The present observational study highlights the usefulness of simulation to evaluate competences of anesthesiology residents to provide GA for emergency CS. The normal distribution of the final score and similarity of scores between both groups reveals the homogeneity of performance of residents, regardless of the year of residency training of the participants.

If on one hand, the analysis of non-completed tasks revealed that only the less specific ones for Anesthesiology (presence of pediatrician, administration of oxytocin) showed high rates, unexpectedly, the same was the case for some tasks considered core to anesthetic practice, such as pre-induction AW assessment. Despite the identification of Difficult AW (DAW) predictors by objective preoperative examination, whether elective or emergency scenarios, being one of the first competences taught to Anesthesiology residents, we observed performance deficiencies in the area, regardless of year of residency. During the debriefing, most residents attributed this flaw to the artificial simulation environment, referring it would not have happened in real-life. Equally, we observed that the fentanyl dosage administered was clearly low compared to normal practice. The low number of GA for emergency CS in which residents participate may explain these gaps, at least partially, and which could be corrected with simulation training.

The lack of evidence does not allow to extrapolate care in a simulation environment as an indicator of behavior in real-life,[4] but the detection of deficits in competences, as those we observed, opens a window of opportunity for enhancing teaching during obstetric anesthesia rotations.

In 2014, Ortner et al.[3] assessed the level of knowledge retention of 24 residents during obstetric anesthesia rotation, in executing GA for emergency CS in a simulation environment, based on an assessment table. The simulation clinical case was carried out at three distinct times: the first after the 1st week, the second after the 5th week and the third at the end of 8 months. On the rotation starting day, all residents attended a lecture on GA for emergency CS and attended a simulated scenario on the same topic. For the first assessed time of study, the mean score obtained was 68% of items accomplished. This result is comparable to our study (64.29%), highlighting whether specific teaching during a simulated clinical scenario leads to the same level of knowledge retention of that acquired during a rotation without any previous training. On the other hand, in a study performed by Scavone et al.[4] two groups of anesthesiology residents were exposed to training at two moments and to a final evaluation, in two distinct simulation clinical scenarios. One group was trained in a GA simulation scenario for emergency CS while the other was trained in a simulation scenario for non-obstetric anesthesia emergencies. Both groups took the final evaluation on GA for emergency CS. The authors observed that the group who trained specifically for the latter scenario showed better performance, 78% vs. 67%. While the result of 67% is similar to our study, the 78%, attained by the group with specific training, is superior than, both our study and the study previously presented by Ortner et al.,[3] supporting the evidence that simulation training of tasks or specific clinical scenarios enhances performance.[8]

Even though the best results attained by residents of Group 1 (2nd and 3rd years) in comparison to those of Group 2 (4th and 5th years) did not show statistical significance, such findings deserve some consideration. Although confidentiality was recommended to all participants regarding the clinical scenario evaluated, it is likely that some information sharing occurred. Moreover, the fact that residents of Group 1 were evaluated right after the end of the rotation, unlike residents of Group 2, who were evaluated after a longer time frame, may also explain the difference in results.

Our study has some limitations. The small sample size reduced the power of statistical analysis. The retrospective design of the study decreased accuracy of registrations, done by direct observation, without using video imaging, generating missing data in the final sample. The impossibility of assuring no information sharing among residents may have been a bias factor.

Among the strong aspects of the study, stands out the fact that it is the first performed in Portugal based on an innovative evaluation tool: holding a clinical case in a high-fidelity simulation environment and conducting it by anesthesiologists with major experience in obstetrics and regular activity in the clinical simulation field.

This study highlights the potential of simulation as an evaluation tool in this scenario, but also shows the need to develop a standardized, practical, and straightforward evaluation model that reflects objective acquisition of competences by residents during obstetric anesthesia rotation, particularly dealing with rare and complex clinical scenarios.

Conclusion

Overall performance of residents in a GA scenario for emergency CS was satisfactory and comparable to other results previously published. The year of residency was not a determining factor for the final score.

Transposition of management in a simulated environment to clinical practice, although pointed out as likely, should not be taken for granted, and should deserve more ample and detailed investigation.

The definition of the training methods and acquaintance with less frequent clinical scenarios is essential for future generations of health professionals. Therefore, designing and improving education plans to improve anesthesiology teaching should be a priority, and the results of this and other similar studies may be the starting point for this process.

Funding

The authors performed the study without receiving financial support.

Conflicts of interest

The authors declare no conflicts of interest.

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