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Research Paper

A simulation program for obstetrical emergencies - Implementing a standardized learning model for emergency situations in obstetrics

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Highlights
Absolving our simulation program significantly improves participants knowledge for at least 3 months.
After participating in the course, the rate of questions answered not or falsewas reduced significantly.
After completing our simulation program the rate of correctly answered questions rose significantly.

Abstract
Background:In 2017, around 810 women died every day worldwidefrom obstetric complications. To prevent newborns growing up without their biological mother it is necessary to improve the perinatal medical assistance of mother and child. Therefore, we implemented a standardized learning model for obstetric emergencies using a simulation program.

Methods:The simulation program was composed as a theoretical and a practical part, which was performed in an interdisciplinary fashion. The participants were asked to answer 14 questions, covering the topics of the course, 2 weeks before and 3 months after their participation, so that the learning effect of the simulation program was reflected.

Results:The possible answers of the survey were: none or false, incomplete and correct answer. The number of none or false answers decreased significantly (p< 0,001) by 30.2%. The number of incomplete answers decreased significantly (p< 0.001) by 27.3%. The number of correct answers increased significantly (p< 0.001) by 57.6%. The total number of false, none or incomplete given answers decreased significantly (p< 0.001) by 57,6%. The quality of all given answers three months after the course was significantly higher in all participants, compared answers prior to the course.

Conclusions: *Following German S1-guideline, we could show, that our simulation program for obstetrical emergencies significantly improves participants knowledge for at least 3 months.*

Keywords:
Anesthesia, Emergency, Obstetrics, Questionnaire, Safety, Simulation training, Teaching

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I. Introduction

Simulation aims at a virtual reproduction of a real situation or realization of the potential of such a situation. In the early 20th century flight simulation was introduced into aviation practice. It has the potential to train emergency situations, which could otherwise not be trained risk free (25). It was not until in the 1980s that

simulation was introduced into medicine by the American anesthesiologist David Gaba (13). The main goal of simulation in the medical field is to increase patient´s safety. To establish a qualitative management standard, which is dominated by a safety culture, the technical operability and communication skills of the staff should be continuously improved.

In 2017 maternal mortality rate in Europe is reported by 0.5% (1). Given the interdisciplinary interaction of obstetricians, anesthesiologists, neonatologists, midwives and nursing staff, managing of obstetrical emergencies is complex. To reduce the mortality risk, the quality and effectivity of the management plan should be guaranteed (28). Furthermore training the necessary skills must be risk free (25). Therefore a field-tested and well-trained communication between the different teams and an increased theoretical knowledge as well as increased practical abilities of team members should be applied to simplify and internalize dealing with complicated procedures in rare emergency situations to prevent maternal death (28).

II. Methods

The „Simulation program for obstetrical emergencies" is composed of a theoretical and practical part. In the first part presentations and case presentations aim to foster theoretical basic knowledge for physicians and nursing staff of the anesthesia and obstetrical departments. Following the German S1-guideline (3), the guidelines of the European resuscitation council (ERC) (20), the guidelines of the American Heart Association (30), the recommendations of the WHO (31) and the guidelines of the DGGG, OEGGG and SGGG (26), we discussed the following topics: emergency caesarean section (CS) including the management of a difficult airway management (17,28), shoulder dystocia (7,9), resuscitation after cardiac arrest of a pregnant woman (20), amniotic fluid embolism, HELLP syndrome, (pre-)eclampsia (12,18) and ante-/postpartal hemorrhage (2,4,5,11,25,31), e.g. in association with uterine rupture, placenta previa and atonic postpartum hemorrhage.

The second part consists of practical training as an emergency drill in small groups of 4 till 6 persons. The simulator has a 1:1 scale to adults and newborns. The small groups reflect the real situation in its composition, as it is formed by anesthesiologists, gynecologists and nurses working together, summing up to maximally 6 persons. Each participant is supervised by a specialist in their own field (e.g. consultant of anesthesiology or obstetric). This supervisor is furthermore supported by another specialist or advanced resident. This allows collecting data about the participants performance based on a standardized checklist preparing the debriefing and manipulating the adverse events in the right moment, without being distracted by the simulation software. The teams and individuals are evaluated after accomplishing the simulation round based on the standardized checklist as well.

Our drills set to include the management of a complicated airway within an emergency caesarian section (CS) (16,27), a shoulder dystocia (7,9,14), an ante-/postpartal hemorrhage (2,4,5,11,26,31) and a cardiopulmonary resuscitation scenario of a pregnant women (20) with eclampsia (12,18). Representing for the clinical scenarios we trained, the emergency caesarian section (CS) is described. It started with a resident of obstetricians recognizing a CTG indicative of fetal hypoxia and followed by alarming the specialist/consultant of obstetricians on duty. The consultant had to enumerate procedures to manage the clinical scenario in favor of a vaginal delivery. When her/his approaches fail, an emergency CS has to be declared to all members of the interdisciplinary team of obstetricians, anesthesiologists, neonatologists, midwives and nursing staff. It is the role of the most senior obstetrician to head the team, distribute roles and perform the surgery. By distributing the roles, the obstetrician has to determine the position, connect the ECG and activate the monitor, secure the i.v. lines and then immediately start prepping the patient, prepare the instruments and position the team for performing the operation until the anesthesia team arrives. On arrival of the anesthesiologiststhe most senior obstetrician sums up the most important patient data and the indication for surgery. The obstetrical team completes preparing the operative theater.

The anesthesia team also prepares for its emergency procedures. Without losing time, anesthesia should be applied. Delegating the following roles like: test the patient position, performance of the preoxygenation, preparation of functioning suction systems, connecting the monitors, testing the iv. access, preparation and application of the emergency and anesthesia drugs, handing over the intubation set, infusion of the uterotonics and antibiotics and ordering the non-matched packed red blood cells, depending on the clinical setting have to be promptly delegated by the team leader of anesthesiology, who should be represented by the most senior anesthesiologist. She/he situates her-/himself at the head of the patient, pre-oxygenates and reassures the patient, e.g. "everything is under control, we are going to watch out for you and your baby". This approach is fundamental and simplifies the whole process. Throughout this critical situation, reassurement reduces the risk of going through postpartal depression (22). The aortocaval compression can be prevented inclining the supine patient by 15° to 30° to the left (20). For all the participants a basic rule applies and has to be followed: "oxygenation prior to intubation". This does not dictate the need to intubate at any cost. To guarantee a proper oxygenation and hence avoiding hypoxia, other oxygenation methods, e.g. laryngeal mask via tube or mask, can be used. The early application of a laryngoscopy with a short handle or a video based laryngoscope, the optimal

position on the intubation pillow, the use of a stylet or a bougie should be considered. Once full anesthesia is applied and the anesthesiologists signal the start of surgery. The obstetrical team performs a "pseudo" surgery to extract the fetus. With the end of the emergency situation, the training module ends.

To assess the baseline knowledge of the participants, each one had to answer a pretest of 14 questions in 25 minutes two weeks prior to the course. The answers of the participants were either scored with a zero (false or no answer), one (incomplete answer) or two points (right answer) (see Fig. 1B). Three months after the course, participants were tested again. The participants were not informed about the planned posttest and were strictly supervised while they answered the questions of the test to avoid manipulation. Based on the results of our pilot study with five participants, using an α error of <0.05 and a study power of 80%, >30 participants were required to detect a significant difference of 1score point to confirm or withdraw the hypothesis.

The statistical evaluation was performed using SigmaPlot Version 11.0 (Systat Software, Inc., San Jose, CA, USA). The Gaussian Distribution and the homogeneity of the variance analysis were proved and the data were displayed as standard error of the mean. Using the t-Test the data was checked for statistical significance, defining the significance level by $p<0.05$.

III. Results

30 Participants (Consultants of obstetricians and anesthesiologists) answered the questionnaire. After participating in the course, the rate of questions answered false or not was reduced significantly (31.2% vs. 1.0%, $p<0.001$). The rate of incomplete answered questions also reduced significantly following the participation in the course (41.7% vs. 14.4%, $p<0.001$), while the rate of correctly answered questions rose significantly from 27.1% to 84.6%, $p<0.001$ (see Fig. 1A). The rate of incorrectly answered questions two weeks prior to the course decreased significantly from 72.9% to 15.4%, $p<0.001$ (see Fig. 1A).

In comparison to the questionnaire two weeks prior to the course, three months later only two questions, questions six and seven, were answered incorrectly or not at all. As shown in Fig. 1B the answer quality for each question increased three months after participating in the course. A significant rise occurred in all questions (question one, two, four, five, seven to fourteen ($p<0.001$), question three ($p=0,006$) and question six ($p=0.02$) (see Fig. 1B).

IV. Discussion

In current literature many approaches of simulation trainings are described. In accordance to the results of Komosawa et al. we chose a team of anesthesiologists, obstetricians and nurses to perform likewise drills (17). In a simulation training reported by Robertson et al., obstetricians, nurses and midwives were chosen as team members (24). Walker et al reported about the training of obstetricians and neonatologists (32), Daniels et al and Johannsson et al trained only obstetricians (15) while Crofts trained obstetricians and midwives (6). The enormous potentials to foster the team performance is reported in all mentioned publication. Simulation programs as described above have wide variations in participants, techniques and situations trained. Therefore,the comparability of the published results is limited. In all cases, optimizing the team performance targets leads to the improvement of patient safety (6,15,17,24,32).

The team members of the simulation drills are chosen based on the pathology. Deering et al described the importance of recognizing the bleeding cause and entitiy (10), while Daniels et al described a training course of managing the postpartal bleeding with obstetricians (8). Basing our course on their concepts, we achieve a targeted and problem oriented therapy of postpartal bleeding, as an obstetrical emergency. Furthermore, our simulation program for obstetrical emergencies is based on a similar course of the Royal College of Obstetrics and Gynecology (RCOG) (23). The SimMOM® offers the possibility of a high fidelity training. Linking the dummy with a specialized computer and software establishes a real simulation of a vaginal delivery, shoulder dystocia or postpartal bleeding (19). Other authors described similar effects with other commercially available products for simulation of obstetrical procedures or ultrasound (6,23,32). Shoulder dystocia is the best example for simulation training, which is why we added this module to our drills (7). Deering (9) and Goffman (14) et al describe the importance of the team communication as a fundamental component in the management of shoulder dystocia. A similar simulation was performed using a low fidelity dummy with a pelvis trainer manikin by Crofts et al (7). As presented by Ellis et al. (12), Thompson et al (29) and Daniels et al (8) these emergencies could be simulated using a simple dummy. In accordance with the study results of Crofts et al. (7) we chose a computer based simulation dummy instead. Our highest priorities were to optimize the effectiveness of the team training, increase the individual knowledge and improve patient safety. Therefore, we included realistic work environment, e.g. by rebuilding an operation room with functioning equipment, real material and an interacting patient (the computer based dummy). Based on the results of Ellis et al (12) and the ERC-Guidelines (20), our drills set to include the management of a cardiopulmonary reanimation of a pregnant woman (20) with eclampsia (12,18). Drills of these complex situation within an interdisciplinary team of obstetricians,

anesthesiologists and nursing staff was extended to include the effects described by Croft, Walker, Komasawa, Daniels and Robertson and contained communication and coordination between the different teams (6,8,24,32).

The teams and individuals are evaluated after accomplishing the simulation round based on the standardized checklist. As highlighted by Mushambi et al, using the method of standardized teaching helps to bring consistency in clinical practice, minimize adverse events, improve anesthetists and team performance during a crisis (21). This study shows the benefits of our advanced clinical simulation of maternal and neonatal emergencies within interdisciplinary teams, because the participant's knowledge significantly improves for at least 3 months. Based on the results of Mushambi et al (21), we postulate that if different team members, anesthesiologists, gynecologists and nurses, absolve our simulation program for obstetrical emergencies, they will be able to equally recognize the critical situation, follow identical aims and apply evidence based guidelines with the same intensity. Therefore, the used terminologies, knowledge of causes, complications and management of a certain situation have to be well trained.

Our study has some limitations. In this study we verified the effectivity of the simulation training with theoretical tests. We choose a questionnaire to evaluated the participants knowledge anonymous, objective, exactly quantifiable and without interview effects. Further on the practical part of our simulation training is limited on the local equipment of our University Hospital and the fact that not all aspects an alive patient shows e.g. colour of the skin could be shown by the simulator. In this case, additional information was given to the participants by the instructors.Based on the fact, that practical abilities increase after knowledge improvement, further studies are planned to examine if and how our simulation training increase the practical abilities, e.g. be able to equally recognize the critical situation, follow identical aims and apply evidence based guidelines with the same intensity.

V. Conclusion

Following German S1-guideline, we could show, that our simulation program for obstetrical emergencies significantly improves participants knowledge for at least 3 months.

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Figures

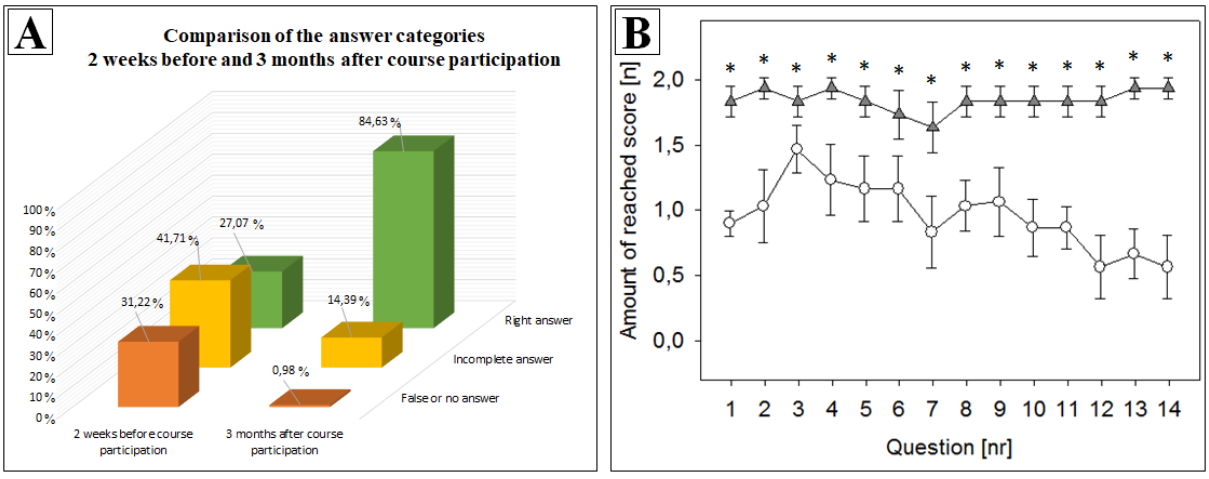

Figure 1: Results of the questionnaire´s evaluation

Comparison of the results of the questionnaires two weeks before and three months after the course participation. (A) Percent of red = false or no answer, yellow = incomplete answer and green = right answer per question. Data in rounded %. (B) Amount of reached score [n] (zero points = false or no answer, one point = incomplete answer and two points = right answer) two weeks before (white circle) and three months after (grey triangle) the course participation of all participants per question. Data in mean + SD.

Appendix

1. Questionnaire:

Which indications of an emergency CS do you recognize?
How is the decision-delivery interval defined?
Which teams have to be present in an emergency CS?
You arrive at an emergency CS theater. A pregnant woman is strapped already on the operation bed. The colleagues connected meanwhile the monitors. Which further prerequisites have to be met before inducing anesthesia? Which Equipment has to be available?
How do you deal with an unexpected intubation situation in case of an emergency CS?
Which drugs do you use to induce anesthesia in an emergency CS? Please mention the order of application.
Which drugs do you consider to use when a trigger free anesthesia in case of an emergency CS is planned?
Which drug do you applicate after cord clamping?
Which uterotonics and at what dosages do you apply in case of an atonic postpartal hemorrhage?
Where do you refer the patient after atonic postpartal hemorrhage? Give a reason for your decision.
Where do you refer the patient after an emergency CS? Give a reason for your decision.
How is the targeted coagulation therapy in peri-/postpartal bleeding defined?
What are possible causes of peri-/postpartal bleeding?
What procedures are important in case of a CPR in a pregnant patient after 20 weeks of gestation? Describe the pathophysiological mechanism that leads to applying this procedure.

2. Glossary of abbreviations used in the text (in alphabetical order):

DGGG Deutsche Gesellschaft für Gynäkologie und Geburtshilfe e.V.
ERC European Research Council
RCOG Royal College of Obstetricians and Gynaecologists
CSCaesareansection
SDstandard deviation
OEGGGÖsterreichische Gesellschaft für Gynäkologie und Geburtshilfe e.V.
SGGGSchweizerische Gesellschaft für Gynäkologie und Geburtshilfe e.V.
WHOWorld Health Organization
HELLPHemolysis, Elevated Liver enzymes, Low Platelets
CTGCardiotocography
USAUnited States of America
ECGElectrocardiogram

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