Simulation as a learning resource in medical education

A simulação como recurso pedagógico no ensino médico

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Resumo

Introdução: O uso da simulação no ensino médico assegura uma melhoria na aprendizagem e um acréscimo de experiência, sem o risco dos eventos reais. A ausência de treino prévio na execução de procedimentos técnicos pode associar risco para o doente, indissociável da técnica em questão. Assim, a educação e o treino em segurança são decisivos para a prevenção do erro médico. Neste contexto, a simulação tem um papel determinante.

Diferentes abordagens, como cenários híbridos realidade-simulação, manequins de alta-fidelidade e realidade virtual são usadas em simulação enquanto recurso de ensino médico.

A simulação pode ser utilizada na aquisição de competências técnicas e competências não técnicas, como o trabalho de equipa, a comunicação em equipa e a comunicação médico-doente. A relação médico-doente pode também ser desenvolvida pelo treino de situações como a comunicação de um evento adverso a um doente ou familiar.

Embora o reconhecimento da simulação como instrumento fundamental na educação médica tenha aumentado nos últimos anos, falta ainda a sua integração na formação médica pré e pós-graduada, tal como a avaliação quantitativa dessa integração no desempenho dos médicos internos e, em última instância, na melhoria assistencial do doente.

Objetivos: Aumentar a eficácia e a segurança da formação em Anestesiologia através da inclusão do treino em simulação como componente obrigatória do programa de formação específica desta especialidade. Para atingir esse objetivo principal, o trabalho foi dividido em três objetivos secundários: 1) Treinar e avaliar, através da construção de um instrumento de avaliação dividido em duas partes: a participação num episódio clínico que desencadeou um efeito adverso num cenário de simulação em contexto de bloco operatório e a divulgação do mesmo evento adverso, num cenário híbrido de simulação; 2) desenhar um programa de formação de competências, em ambiente de simulação, de acordo com os conteúdos programáticos incluídos no Internato de Anestesiologia, incluindo competências técnicas e não técnicas; 3) implementar e avaliar o programa através da construção e validação de questionários de autoavaliação respondidos pelos internos antes e depois de cada curso de simulação.

Resultados: A metodologia que envolveu a utilização da técnica de simulação mista realidade-simulação contou com a participação de 42 internos de Anestesiologia na simulação de um evento adverso e na sua comunicação ao doente. Este estudo permitiu a prática de um conjunto de respostas aos doentes ao longo das diferentes fases do luto. Os instrumentos para avaliar o desempenho e a prática da comunicação do efeito adverso pelos internos de Anestesiologia, apresentaram uma excelente fiabilidade e elevada consistência interna ($p<0,05$).

O programa de formação de competências para internos portugueses de Anestesiologia, desenhado de acordo com os conteúdos programáticos definidos pelo Colégio de Anestesiologia da Ordem do Médicos, contou com a participação de 340 médicos: 76 internos do primeiro ano, 89 do segundo, 82 do terceiro e 93 do quarto e último ano.

Para a avaliação deste programa foram construídos questionários de autoavaliação para serem aplicados antes e depois de cada módulo do programa de simulação. A consistência interna foi testada e considerada elevada em todos os questionários.

Os participantes avaliaram a importância atribuída a diversos conceitos técnicos em Anestesiologia, e a sua formação e experiência antes e depois de cada curso de simulação. Os resultados foram estatisticamente significativos na maioria das comparações ($p<0,05$). Da mesma forma, os questionários permitiram autoavaliar a evolução do desempenho clínico e competências não técnicas, tais como a consciência situacional, o pedido de ajuda, a comunicação e o trabalho de equipa.

Ao longo do tempo, na perspetiva dos internos, a necessidade de apoio e o número de erros aumentaram ($p<0,001$). Os médicos internos assumiram também que ao longo do internato houve uma melhoria da capacidade de comunicação, uma vez que mais facilmente expressam a sua opinião, mesmo discordando do anestesiologista sénior. Realça-se a unanimidade em relação à importância das competências não comportamentais para a excelência da prática clínica, identificada pelos internos do 4º ano no final das formações com simulação.

Por fim, os participantes deram elevada importância a todos os conteúdos programáticos abordados durante os módulos de simulação, com maior relevância nos temas abordados no último ano.

Conclusões: O instrumento de avaliação dividido em duas partes demonstrou fortes propriedades psicométricas para avaliar o desempenho da comunicação ao doente da ocorrência de um efeito adverso. O conceito misto de realidade-simulação permitiu que os internos estivessem envolvidos num evento adverso e treinassem a sua comunicação antes do contato direto com um doente. A construção de um programa de simulação de acordo com os conteúdos pedagógicos do Internato de Anestesiologia melhora não só a formação nesta área, sem colocar os doentes em risco, como tem repercussão no reconhecimento do erro, enriquecendo o valor da autoconfiança e o papel fundamental das competências comportamentais.

No final, este estudo mostrou que a simulação também tem repercussão na identificação de lacunas que devem ser ultrapassadas antes que os internos se tornem independentes, culminando na melhoria da segurança do doente. Em conjunto, os resultados obtidos vêm enfatizar o impacto positivo da simulação como instrumento de aprendizagem do Internato Médico de Anestesiologia.

Palavras-Chave

Anestesiologia; educação médica; competências técnicas; competências não-técnicas; comunicação; comportamento; treino de equipa; simulação.

Abstract

Background: The use of simulation in medical education ensures improved learning and an increase in experience without the risk of real events. The absence of previous training in the execution of technical procedures may involve risks to the patient, inseparable from the technique in question. Thus, medical education is decisive in preventing medical errors, and simulation has a critical role in this field.

Different approaches, such as mixed-realism scenarios, high-fidelity mannequins, and virtual reality, are used in simulation as resources for medical education.

Simulation can be used to train technical and non-technical skills such as team endeavor, team communication, and clinician-patient communication. The latter, which includes the disclosure of an adverse event to a patient, contributes to the increase in the clinician's confidence.

Although the recognition of simulation as a fundamental resource in medical education has been increasing in the last years, there is a lack of implemented courses, as part of pre- and post-graduate medical training, and quantitative evaluation of the impact of these courses in residency and, at ultimately, in patient care improvement.

Objectives: To increase anesthesiology training's efficacy and safety by including simulation training as a mandatory component of Anesthesiology Residency. To accomplish this primary objective, the work was divided into three aims: 1) to train and evaluate, through the construction of an evaluation instrument divided into two-parts: the participation in a clinical episode that triggered an adverse event in a simulation scenario in an Operating Room context and the dissemination of the same adverse event, in a hybrid simulation scenario; 2) to design a skill training program, in a simulation environment according to the programmatic contents included in the Portuguese Residency in Anesthesiology including technical and non-technical skills; 3) to implement and evaluate the program through the construction and validation of self-assessment questionnaires answered by the residents before and after each simulation module.

Results: The comprehensive methodology involving mixed-realism simulation engaged 42 Anesthesiology residents in an adverse event and its disclosure to the patient. It allowed practicing to a range of patients' answers through the different stages of a grief response.

The instruments to assess the performance and the anesthesiology residents' disclosure practice showed excellent interrater reliability and high internal consistency ($p<0.05$).
Three-hundred and forty individuals attended the competencies training program for Portuguese Anesthesiology residents, designed according to the programmatic contents defined by the Portuguese Board of Anesthesiology: 76 from the first year, 89 from the second, 82 from the third, and 93 from the fourth and last year.

For the evaluation of this program, self-assessment questionnaires to be applied before and after each simulation module were designed, and the internal consistency was tested, indicating a high internal consistency of all questionnaires.

Students assessed the importance attributed to several main technical concepts in Anesthesiology, and their training and experience before and after each simulation course. The results were statistically significant in almost all comparisons ($p<0.05$). Likewise, these questionnaires also included questions regarding non-technical skills such as need for help, making mistakes, self-efficacy over time, need for support, communication, and team attitude.

Over time, the need for support and the number of mistakes increased from the residents' perspective ($p<0.001$). However, the students assumed that, through the residency, there was an improvement in the communication skills since they easily expressed their opinion, even if they disagreed with the consultant anesthesiologist. Unanimity is highlighted regarding the importance of non-behavioral competencies for clinical practice excellence, identified by 4^{th}-year residents at the end of training with simulation.

Finally, the residents rated all the programmatic contents addressed during the simulation modules as highly important. The last year's topics were the ones with numerically higher importance attributed by the trainees.

Conclusions: The evaluation instrument divided into two parts demonstrated solid psychometric properties to evaluate the performance of communication to the patient of the occurrence of an adverse effect. The mixed concept of reality-simulation allowed residents to be involved in an adverse event and train their communication before direct contact with a patient. The construction of a simulation program according to the Anesthesiology Residency's pedagogical contents improves training in this area without putting patients at risk. It has repercussions on recognizing the error, enriching the value of self-confidence and the fundamental role of behavioral skills.

In the end, this study showed that simulation also has repercussions on the identification of gaps that must be overcome before the residents become independent, culminating in improved patient safety. Together, the results obtained emphasize the positive impact of simulation as a learning instrument of the Medical Residency in Anesthesiology.

Keywords

Anesthesiology; medical education; technical skills; non-technical skills; communication; behavior; team training; simulation.

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List of Acronyms

ACGME	Accreditation Council for Graduate Medical Education
ACRM	Anesthesia Crisis Resource Management
ALS	Advanced Life Support
ARDS	Acute Respiratory Distress Syndrome
ARP	Anesthesiology Residency Program
BARS	Behaviorly Anchored Rating Scale
BSC-CHUC	Biomedical Simulation Centre from Centro Hospitalar Universitário de Coimbra
BLS	Basic Life Support
CanMEDs	Canadian Medical Education Directives for Specialists
CHUC	Centro Hospitalar Universitário de Coimbra
CI	Confindence Interval
CONSORT	Consolidated Standards of Reporting Trials
CRMA	Crisis Resource Management in Anaesthesiology
CSB-CHUC	Centro de Simulação Biomédica from Centro Hospitalar Universitário de Coimbra
DBR	Daniel B. Raemer
FMM	Francisco Maio Matos
GRP	Gabinete de Relações Públicas
OR	Operating Room
PACU	Post-Operative Care Unit
PBL	Problem-based Learning
PCE	Patient-centered Education
SD	Standard Deviation
SP	Standardized Patient
SPSS	Statistical Package for the Social Sciences (originally, now outdated)
STROBE	Strengthening the Reporting of Observational studies in Epidemiology
UBI	Universidade da Beira Interior
USA	United States of America

Chapter 1: Introduction

1.1 Medical error

Preventable medical errors are the third leading cause of death in the U.S., responsible for over 400,000 deaths per year.[1] Data from the World Health Organization showed that, in European countries, mostly from European Union Member States, 23% of the citizens claim to have been affected by medical error and 18% of the 23% experienced a serious medical error.[2]

Medical errors are common and diverse and can occur at every level of the system.[3] At the beginning of this century, Kohn tried to separate medical errors into two parts: error of execution and planning error. Two other terms were defined: *adverse event,* as injuries that can result from medical approach rather than from underlying disease; and *patient safety,* that is the absence of preventable harm.[4] These three terms, medical error, adverse event, and patient safety, complement each other. Some authors advocate that a preventable adverse event is an error; however, preventability has never been rigorously measured. Preventability pretends to achieve a trustworthy healthcare delivery system, minimizing the incidence and impact of and maximizing the recovery of adverse events. Moreover, errors should not be considered equivalent to negligence. A large circumstantial component should be included in errors whereas negligence is a failure to meet a standard of practice and can be considered an extreme level of fault.[5]

The medical process is complex and, consequently, each part is affected by the functioning of other parts within the system: even small errors can result in large system consequences. There are some medical departments, such as the emergency department, where the intervention performed is aggressive, precludes prior robust medical information, and should be taken in seconds, where the rates of error are higher due to the challenging environment.[6]

The definition of a medical error may vary.[5] Moreover, how the physician perceives his performance, his colleagues´ performance, and what is chosen by the clinician to be reported also varies. The notion of error can vary through the physician's professional life, even during residency time. In junior doctors, within the first five years after graduation, there are several reasons for the occurrence of more adverse events due to low experience in more emergent situations and unusual clinical syndromes, exhaustion due to long duty hours, distraction caused by multiple clinical events, management of unsupervised critical events or without adequate debriefing, insufficient knowledge and inability to confirm and clarify directions.[7]

Around 50% to 70.2% of medical errors can be prevented through comprehensive systematic approaches to patient safety.[5]

Strategies to reduce adverse events would lead to the prevention of more than 750,000 harm-inflicting medical errors each year in Europe. One of the recommendations of the Institute of Medicine (United Stated of America) is the need to restructure medical education to overcome learning and performance gaps, promoting safety across the world.[8]

What are the causes of these errors and what can be done to prevent them?

Traditional medical education is designed to decompose healthcare tasks in smaller components with the purpose of teaching. With this approach, there is a lack of adaptability of the different skills to clinically meaningful and relevant situations. Moreover, non-technical skills such as situation awareness, risk assessment, clinical decision making, leadership, communication skills, and teamwork are not covered by traditional medical education.[9]

Medical education has evolved in the last century from a passive education based on a master-apprentice model with the main focus of teaching to a patient-centered education (PCE). PCE is based on respect for patient's needs, preferences, and values, as well as on problem-based learning (PBL), an interactive teaching method that uses written cases as a stimulus for the acquisition and application of knowledge in a clinical setting. In this educational model, there is a scripted scenario based on the instructor's confidence and feedback.[10]

Finally, more recently, a holistic approach based on simulation has been used to promote consolidated learning in authentic tasks, aiming at reducing the risk for unexpected emergencies, namely at unfamiliar locations such as hospital Emergency Rooms.[7,8] Simulation can complement traditional clinically based training, exposing students to uncommon situations/emergencies. The use of simulation and traditional medical education allows for the development of clinical reasoning, which could be interpreted as the higher level of Miller´s Pyramid that all the learners must acquire to develop an accurate diagnostic hypothesis and provide high-quality patient care.[11]

The use of simulation-based medical education, as a complement to real clinical education, is useful for several reasons[8,12]:

- Overall, control the sequence of tasks offered to the learners. Students should start with more manageable tasks during the educational path and proceed to more complex/changeling ones. In the real world, it is difficult to achieve this stepped approach. In a simulation environment, tasks can be tailored to the educational level, are reproducible and standardized.

- There is an opportunity to provide support and guidance. Support and guidance in traditional models are provided by interactions between junior and senior healthcare professionals and the changes in the healthcare system condition these interactions. In a simulation, it is possible to pause, restart, and replay a specific situation increasing its impact on the learning process.

- Allows preventing unsafe and dangerous situations. Failure and its recognition are crucial and can change during the learning process. It is fundamental for learners to understand when they are approaching their limits or even cross them. The simulation environment allows for that without being a threat to patient safety.

- Allows practicing clinical situations with high risk and low incidence. Some clinical scenarios are rare in the clinical setting, and therefore their creation in a simulation environment allows to learn and practice earlier, improving performance in a real experience and beyond theoretical knowledge.

- Allows creating tasks that are impossible due to limited materials or resources. Learners will only be able to practice some specific medical procedures under simulation. These specific procedures include technical competencies and non-technical competencies (such as behavior) and multidisciplinary team competencies.

1.2 Simulation

Simulation is a technique through which experience can be acquired without going to the real event.[8] This artificial representation of complex real-world processes aims to, with sufficient fidelity, facilitate learning through immersion, reflection, feedback, and practice in a safe environment without the risks of real-world experience.[7,13] Simulation training is a prerequisite for all high-reliability organizations including airline, nuclear, and oil industries.[13]

Simulation-based medical education has been reported since the 17th century in France using mannequins, mainly birthing training.[14] Simulation with standardized patients (SP) or full-body mannequins has been reported since the late 1960's.[15] Nowadays, it is recognized as an integral part of medical education mainly due to the decreased opportunity to practice on real-world patients and the growing awareness regarding patient safety.[16]

The medical education paradigm is changing from the traditional experience-based model, which includes lectures, tutorials, laboratory works, and bed-side consultation, to programs that require documentation of proficiency. Furthermore, traditional education is considered a compartmentalized education since it continuously decomposes healthcare tasks to simpler or smaller components, not allowing the students to grasp the dynamics of variation of the various components in a clinically meaningful and relevant way. Moreover, young doctors' training opportunities are reduced since it is not acceptable to practice new skills on patients, even with the patient´s consent.[7,13,17] To overcome these difficulties and constraints, medical simulation is a useful adjunct.[8]

In the context of teaching and training, simulation has three main steps[14,16,18]:

1. initial briefing – pre-simulation explanation and guidance. It includes a previous plan with protocols. However, flexibility should be allowed to test unplanned objectives generated by learners. The objective is to let students feel psychologically safe during the following two steps;
2. simulation experience – the main part of simulation education where students undergo simulated clinical scenarios focusing on either technical or non-technical skills;
3. debriefing – core component providing students the opportunity to reflect on different aspects and improve their clinical practice. The first approach is to share emotional reactions, the second is a deep reflection and analysis, and finally, the students summarize the lessons learned.

The term fidelity is a common term used in simulation. It describes the degree of realism and complexity of the models. Medical simulators can be separated by the level of fidelity: low-fidelity, medium-fidelity, and high-fidelity, as described in Table 1. 1. Low fidelity models can be developed and updated swiftly, while high-fidelity models have a higher cost of engineering and technical support; however, these are more flexible for different uses.[7] Full-body mannequins are used in high-fidelity simulators and behave as real patients that speak to the learners with consciousness, breath with measurable gases, have peripheral pulses, blood pressure, blink, have pupillary reaction to light, and produce urine. Moreover, the cardiac rhythm is visible on the monitors, and medication produces appropriate responses based on pharmacological algorithms aligned with age and gender.[8] Furthermore, the level of immersion can be increased if a realistic working environment, such as a simulated Intensive Care unit or operating theater, is created. The observers' and video cameras' feedback will assist, as a starting point, in the learners´ skills improvement.[7] Besides the advances in technology, some scenarios are too complex and difficult to simulate conceptually, including skin color and facial expression and an inability to respond accurately after a clinical intervention. Progress is being made to overcome these questions.[8]

The advantages of mannequin-based computer simulators are[7]:

- Students´ skills can be applied and refined in realistic situations;
- Learning is adequate to students' educational needs;
- An unlimited number of dangerous and otherwise costly situations can be created;
- The practice can be repeated to reach proficiency;
- The reinforcement allows guideline adherence;
- Interprofessional relations can also be integrated;
- Each scenario can be assembled anytime for the discussion of strategies;
- An improvement of the learning curve with high retention time;
- Quality improvement tool: early detection of systematic/organizational deficits;
- There are no concerns about patient safety or confidentiality.

Table 1. 1 – Classification of simulators as per fidelity[7]

1. Low-fidelity simulators	
1.1 Screen-based text simulators	Create scenarios where the user can select one of several responses; Based on the user´s choice, a new text is generated, and more management choices are offered.
1.2 Static mannequins	Use hands-on practice.
2. Medium-fidelity simulators	
2.1 Screen-based graphical simulators	Particularly well-suited to demonstrate physiological modeling and pharmaco-kinetic and dynamic processes associated with drug administration; Usually, only a mouse interface is involved.
2.1 Mannequins with mechanical movement	Includes a mannequin and software which can simulate the interaction between a student and teacher; Computer-based pictures help confer practical skills; Includes a range of normal variation.
3. High-fidelity simulators	
3.1 Non-physiologic (static) programming	Manually set parameters dependent on the operator; Parameters need to be reset after an intervention.
3.2 Physiologic programming	Parameters change from baseline dependent on intervention and independent of the operator; The automatic generation of appropriate physiological responses to treatment intervention in the mannequin is allowed.

A meta-analysis performed with studies comparing the outcomes of technology-enhanced simulation training for health professional students with no specific intervention concluded that the simulation is consistently associated with significant effects on knowledge, skills, and behaviors. Nevertheless, moderate effects on patient-related outcomes were found.[19] This is the major concern regarding simulation-based education. A few studies reported a solid foundation of simulation in clinical practice change, leading to studies' urgency to assess and systematically quantify simulation benefits and effectiveness.[14,20] Standardization and the quality of reporting will allow to achieve consistent results between studies. Few studies have reported how simulation training is implemented: organizational, administrative, and logistical perspectives.[21] Extensions of the Consolidated Standards of Reporting Trials (CONSORT) and Strengthening the Reporting of Observational Studies in

Epidemiology (STROBE) statements were recently developed to help improve the quality of reporting in simulation-based research.[22]

A commonly cited limitation of medical education-based simulation is the lack of realism of mannequins, cost, and human resources allocation (training and teaching).

High-fidelity simulators are costly, and therefore we should have in mind that some simulation training, as described in Table 1. 1, can be effectively performed with lower fidelity mannequins, reducing equipment costs. Another way to reduce simulation costs is using SPs or "trained actors" to facilitate healthcare professional-patient interaction.[23] SPs are a highly reliable educational tool that has been widely used to train medical professionals.[24] The benefits of using SPs include clinical knowledge and attitudes, promoting relationships with other health care providers.[24]

Virtual reality is an emerging new method of delivering simulation. It is a technology in which the user becomes completely immersed in an interactive virtual environment, using a virtual headset. This experience allows the user to learn in a virtual world.[25] Together with virtual reality, also augmented reality has been used in the field of education. Augmented reality overlays digital interfaces upon physical surroundings that produce real and digital environments.[26]

The maintenance of high-quality medical education standards based on simulation is also dependent on the trainers' quality. The desired results are only possible if the infrastructure is created to ensure sustainability.[8]

Furthermore, for creating an effective learning environment for adults, there are needed terms for a complete and fruitful experience. These include the team of learners that have or would interact in real situations; the environment and the equipment must resemble a real clinical environment; the learning experience should be real problem-centered; learners should feel free to express their opinions and receive different feedbacks from all the participants in the simulation scenario.[8]

1.2.1 Simulation education in Anesthesiology

As a hands-on specialty, Anesthesiology is a field where residents should learn and master different techniques such as tracheal intubation, lung isolation, difficult airway management, central venous catheter placement, and regional anesthesia. The integration of medical knowledge should be sufficient for symptom evaluation following simultaneous diagnostic and therapeutic intervention.[18] For this, with the support of simulation, residents can train the aforementioned skills in a safe learning environment without putting real patients at risk. Moreover, the simulation environment allows for residents to gain experience with emergencies or complications in a controlled and reproducible manner.[16] Besides these technical skills, simulation also allows Anesthesiology residents to learn non-technical skills such as communication, leadership, teamwork, situation awareness, and decision making, which are fundamental skills for these trainees and our main focus of simulation education.[27,28] Some authors considered these non-technical skills as the "art of medicine" that impact the human experience, the healthcare system, and the understanding of illness and suffering.[29]

The inclusion of non-technical skills in simulation programs as cognitive, interpersonal, and decision-making is crucial since they can hardly be acquired with standard educational methods. Moreover, these skills should be included and prioritized in the evaluation process.[27,30,31]

Many Anesthesiology programs incorporate time in the anesthesia simulator during the first month of the first residency year to monitor, evaluate and teach new students the practice of clinical anesthesia. It is essential to improve patient safety.[27,32]

Assessment of the resident's performance is a primordial task in education.[33-35] With simulation programs in Anesthesiology, patient safety is preserved, and performance and learning gaps are identified.[36] The residents' evaluation under pressure and under stressful conditions in real-world conditions may prevent them from showing their competencies.[37] However, the number of available tools for evaluations is scarce, and few published studies have addressed these aims. Moreover, the real-world evaluation process is not uniform for all students due to the intrinsic variation of the clinical situations.[16] Simulation-based training allows to overcome these issues, through a safe and uniform process for all students. Nevertheless, the evaluation process based on simulation is not as common as simulation-based training, and more studies are needed to demonstrate the efficacy of simulation in predicting future performance in the clinical setting.[16,38]

How simulation education should be used in the Anesthesiology residency is not clear. In the United States, residents must participate in at least one simulated clinical experience each year.[39] Although the benefits and advantages of simulation training in Anesthesiology have been largely demonstrated, some issues are still debatable [40,41]:

- The best type of simulator – high-fidelity mannequins replicate real clinical conditions. However, some authors have reported no significant differences between the groups trained in high-fidelity simulators and those trained in low-fidelity simulators.[42-44] More important than choosing the model should be to structure the simulation experience as progressive training in a consistent curricula.[45]

- Contribution of simulation education to improve patient outcomes – the Kirkpatrick classification is widely used to evaluate education intervention outcomes. This classification has four levels of educational intervention outcomes (Table 1. 2).[46] The first three levels of this classification have been documented in different studies; however, there is little evidence about the role of simulation-based education in improving Kirkpatrick level 4.[19,47-50] Further research is needed to systematically evaluate patient outcomes.

Table 1. 2 – Kirkpatrick classification[46]

	Level	**Details**
Level 1	Reaction	Learner´s satisfaction and confidence
Level 2	Learning	Learner´s skills and knowledge
Level 3	Behavior	Changes of healthcare providers in the clinical setting
Level 4	Impact	Improved patient outcome

Technical procedures are increasing in the Anesthesiology field. Consequently, and given that simulation-based training is resource-demanding, it must be prioritized and optimized. However, the strategic implementation of simulation curricula in the proper training context – the correct event by the learner's level at the correct time – is a challenge.[51] A recently Delphi-based method generated a consensus on 30 technical procedures that should be included in simulation-based training in Anesthesiology, which could guide future curricula development for the training of technical procedures.[52] However, this does not include the concordance between the event and the level of the student.

In Portugal, taking other European Countries as an example, simulation-based training was developed according to the Portuguese Anesthesiology Residency Program (ARP).[53] The program was divided into four modules, based on the four years of residency. Beyond the technical skills specific for each year of residency, all the simulation modules include training in non-technical skills. The programmatic content of each module and components that are common to all the modules are schematized in Figure 1.1.

Simulation Modules Content

Importance/training/expertise in:
- airway management
- ventilatory monitoring
- cardiac monitoring
- neuromuscular block monitoring
- clinical practice
- crisis resource management
- advanced life support
- operating room (OR) emergencies
- critical events

Behavioral:
- help
- support
- mistakes
- responsibility

Team training
Importance of simulation programs

Year I
- Basic pharmacology in Anesthesiology
- Basic and advanced airway
- Ventilation
- Ultrasound in anaesthesia
- Central and peripheral cannulation using ultrasound
- Neuroaxial anesthesia and local anesthetics
- Etiology and prevention of cardio-respiratory arrest
- Advanced life support

Year II
- Leadership and health management
- Difficult airway managemet
- Supraglottic and transcutaneous devices
- Fibroscopy principles
- Ultrasound in anesthesiology
- Ultrasound guided regional blocks
- Anaesthetic approach to the burnt patient

Year III
- Assessment of a trauma patient
- Massive haemorrhage management
- Pathophysiology and management of Acute Respiratory Distress Syndrome (ARDS)
- ARDS ventilation
- Pathophysiology of sepsis
- Management of a septic patient
- Anatomy-physiological changes of pregnancy
- Labour analgesia
- Obstetric emergencies

Year IV
- Effective communication
- Crisis resource management in Anaesthesiology
- OR emergencies

Figure 1. 1 – Plan of the simulation courses from the Biomedical Simulation Center – Centro Hospitalar e Universitário de Coimbra, Portugal.

Chapter 2: Objectives

Residents in Anesthesiology show gaps in theoretical knowledge such as guidelines, evaluation before surgery, and skills in using specific equipment. Moreover, clinical care complexity is increasing, and it is responsible for the need for communicative and coordinative ability. Communication includes team and clinical-patients communication. Improvement of this skill strengthens the confidence and, thereupon, safety, which is of the utmost importance to patients.

Anesthesiology departments need protocols and team programs that are as important as the learning of theoretical knowledge.

Based on this, the main objectives of this work were:

- To train and evaluate, under a mixed realism-simulation environment, Anesthesiology residents' performance in the disclosure of an adverse event.
- To design a program of competencies training based on the Portuguese Board of Anesthesiology recommendation for each year of residency.
- To implement and evaluate the program by constructing and validating self-assessment questionnaires to be answered by the residents before and after each course.

The work's ultimate objective was to increase the efficacy and safety of Anesthesiology training through the implementation, at national level, of this program as a mandatory component of the Anesthesiology training program.

Chapter 3: Mixed-realism simulation of adverse event disclosure: an educational methodology and assessment instrument

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3.1 Introduction

The patient-physician relationship is based on trust, loyalty, knowledge and respect. When adverse events occur, they can test the foundation of that relationship and have lasting consequences for both the patient and the physician.[54] Learning how to effectively disclose to patients and families is a requisite skill in physician education.

Although it has long been recognized that physicians have an ethical duty to disclose adverse events when they occur, recent attention has been focused on the mechanics of an effective disclosure. Many professional bodies have established guidelines, which generally recommend at least three components in the process of disclosure: the truth about the incident, an apology, and reassurance that measures will be put in place to prevent a recurrence.[55,56]

Despite ethical imperatives and available guidelines for the process,[57-61] studies of the disclosure have shown gaps between the recommended and actual practice.[55,62-65] Physicians in practice may not be open, honest, and thorough when disclosing adverse events for multifactorial reasons.[66] Avoidance of difficult conversations, reluctance to deal with a patient's feelings, fear of litigation, and concern that disclosure will not benefit the patient have been reported as the main causes for physician's failure to discuss adverse events fully and openly with patients.[67-69]

For many medical trainees, experience with adverse events comes during actual patient care without the previous benefit of formal education about the process of disclosure.[70,71] Like practicing physicians, most trainees feel responsible, experience a strong emotional reaction, and believe that patients should be told of errors in their care, but there is little known regarding their skills in doing so in practice.[27]

Various strategies have been used for teaching adverse event disclosure.[72] Didactic approaches permit the efficient presentation of core concepts to a large number of learners, but the discussion is limited and there is no opportunity for practice or feedback. Small-group sessions allow the discussion of concepts, skills, and concerns, but do not offer an opportunity for practice or feedback. Small groups with peer role-play (one of the participants acts as a patient) add the practice of skills with feedback and an insight to the patient perspective but can lack realism owing to the untrained and inexperienced "patient". A Standardized Patient (SP) - an actor trained to realistically portray a patient in an educational or examination session -[73] is sometimes added to improve realism. Standardized patient sessions may lack engagement because the adverse event is simply described to the trainees, and they may have little stake in the course of care. Combining simulation exercises, where clinical care is provided to a mannequin and disclosure of adverse events is then conducted using a SP, so-called mixed-realism simulations, have been used to improve the engagement.[74] Teaching opportunities during clinical care where an adverse event has occurred are certainly realistic and engaging for a trainee observer; however, they are usually a poor time to allow trainees to practice. They are also rare and happenstance with respect to a particular trainee's participation and are, therefore, educationally inefficient. Furthermore, asking trainees to perform a procedure (e.g., disclosing an adverse event) for the first time, without the benefit of formal instruction and practice, raises ethical concerns and may cause trauma to the trainee and/or patient.

We sought to develop and test a structured technique for learning to disclose adverse events using a mixed-realism model. This technique would involve four stages. First, the learners would participate in a realistic simulation using a mannequin patient in an acute care situation where they would become enmeshed in a clinical episode leading to an adverse event. Second, the learner would be asked to disclose the adverse event to a SP or family, wherein the SP would systematically move through epochs of grief response according to the Kübler-Ross model [75], namely, denial, anger, bargaining, depression, and acceptance. This disclosure would be video recorded for later evaluation. The third stage would be a debriefing. During the debriefing, the learners would be encouraged to discuss their feelings, explore ideas about disclosing, learn techniques for responding to patient reactions, and reflect on their learning from the exercise. The fourth stage would be for the evaluator to review the video recording of the disclosure and to rate the performance using an assessment instrument.

Thus, the purposes of this study were to 1. demonstrate the feasibility of a structured technique for teaching adverse event disclosure using mixed realism simulation, 2. develop and begin to validate an instrument for assessing performance, and 3. describe the disclosure practice of a representative cohort of Anesthesiology trainees.

3.2 Methods

3.2.1 Subjects

With Institutional review board approval, this study was conducted as part of regularly scheduled daylong simulation-based Crisis Resource Management courses at the Center for Medical Simulation in Cambridge, Massachusetts. Participants in consecutive courses from November 2008 to December 2011 were included. Forty-two Anesthesiology trainees in their third to fourth postgraduate years from three different teaching hospitals participated as they were assigned to each simulation course by their institutions on an availability basis. All subjects had previous experience with similar simulation-based courses, as they are required to participate as part of their training on a yearly basis. No subject reported receiving prior specific education on disclosure and apology during their Anesthesiology residency. The subjects received no incentive for their participation. The duration of each course was approximately seven hours, during which the adverse event disclosure case was second or third out of three to five cases.

3.2.2 Disclosure exercise design

To evaluate resident's ability to disclose adverse events, we developed an exercise with mixed realism simulation, divided in two parts. The first part takes place in a simulated OR (OR) and the second part in a simulated postoperative care unit (PACU). For two trainees to have the disclosure experience, we had each subject sequentially care for the patient in the OR and then both speak to the patients in the PACU as a pair. Both parts of the exercise were video recorded for debriefing feedback and for this study.

One subject is called to take over anesthesia care of a mannequin patient (Laerdal SimMan 3G™, Stavanger, Norway) undergoing gastric bypass surgery from an anesthesiologist (actor) who presumably had started the case. The patient is a 55-year-old man with a history of morbid obesity, hypertension, diabetes, and coronary artery disease. During the initial anesthetic care, the patient had a hypotensive episode, and the vaporizer was turned down very low. At the time of handover, the patient is tachycardic and hypertensive and the displayed end-expired anesthetic agent concentration is relatively low, such that a period of inadequate anesthesia would be plausible. If the subject increases the vaporizer setting, the end-expired anesthetic agent concentration increases slowly. The surgery proceeds uneventfully, and the patient remains reasonably stable throughout. During the operation, the surgeon, the scrub technician, and the circulating nurse (all actors) conduct a lively conversation regarding restaurants, food, and weight control. The conversation is arguably inappropriate, although not exaggerated beyond the boundary of the banter that sometimes occurs in real ORs. At one point in the conversation, one of the actors tries to engage the subject by asking if they have ever been to one of the restaurants being discussed or if they like a certain food or have a restaurant recommendation for the others. Shortly thereafter, one of the actors makes direct reference to the patient's body habitus by warning someone else not to "wind up like a whale, like this guy". A second subject is then brought to the OR and asked to take over the case from the first subject who is needed elsewhere (this was done to allow two subjects to participate in the case). After the case is handed over to the second subject, and the first subject has left the room, the surgeon, scrub technician, and circulating nurse resume the conversation about food and obesity as before. Again, the actors attempt to engage the subjects in the conversation and the patient's body habitus is mentioned. This first part of the exercise is ended with the surgery still underway and the patient stable. The two subjects and other participants in the course are asked to retire with one of the course instructors for a discussion of the case.

After approximately five minutes of discussing the clinical management of case, the second part of the exercise begins. The discussion is interrupted by a telephone call from the PACU requesting that the two subjects address a problem with the patient they had just been taking care of. In this part of the exercise, the patient is now an actor rather than the mannequin. Over the course of several minutes, the patient actor reveals that he has heard a conversation in the OR regarding food and obesity and believes he was being talked about and made fun of during his surgery. In a semi scripted structured manner, the patient actor displays an appropriate and realistic emotional response to the intraoperative awareness. The scripting is such that the actor displays, in order, five stages of grief according to the Kübler-Ross model[75]: denial, anger, bargaining, depression and acceptance. The content of each stage is prescribed, though the exact script is dictated by the response of the subjects. The content of the stages is as follows: (1) Denial - he expresses disbelief that he could have heard these things as he was told he would be asleep during his operation. He demands the subjects to tell him that he was dreaming. However, he accurately mentions specifics of the conversation including the names of the restaurants and food that were discussed. He claims to recognize the voices of the subjects although he had not met them preoperatively. (2) Anger – he is incensed that professional anesthesiologists could not keep him asleep as they are supposed to do. In addition, he is irate that people were talking about things other than his medical care during surgery and is particularly angry that he was called degrading names. He insistently accuses the subjects of having called him a whale. (3) Bargaining – he wants some retribution for his inappropriate experience such as the people in the room should be disciplined or fired. He tells the subjects that maybe, they should lose their jobs as well. He wonders openly that this probably happens all the time and nothing is done to punish wrongdoers. (4) Depression – he asks tearfully if he should even have undergone the operation. He reveals that he has been made fun of his whole life and fears it will never end if even professionals humiliate him. He tells the subjects that this has been the most difficult decision of his life and now this degradation has happened as a sign that he made the wrong choice. (5) Acceptance – he asks what will happen now. Moreover, he asks if his mother can come to visit him in the PACU because they would not let her in before. He alludes to not wanting to be left alone in his grief.

Following the second part of the exercise, one of the instructors conducts a thorough debriefing discussion of the case with the subjects and other participants in the course. Subjects covered are the conduct of the case, causes of intraoperative awareness, professionalism in the OR and the anesthesiologist's role, as well as disclosure of the adverse event to the patient.

3.2.4 Disclosure exercise implementation

The first six sessions were used for rater training and had a variety of actors as the patient. The subsequent 15 sessions used in the study had one actor as the patient throughout.

To begin to validate the instruments, the two investigators served as raters. One of the investigators participated in the adverse event disclosure exercise (DBR) and the other did not (FMM). One of the investigators was also the study actor (DBR).

3.2.5 Assessment instrument

We developed a paired assessment instrument using both (1) a behaviorally anchored rating scale (Behaviorally Anchored Rating Scale (BARS) for disclosure instrument) to assess the performance on adverse event disclosure and (2) an objective skills measure (5-Stages Instrument) to evaluate the approach to patient's five stages of grief.

The BARS for disclosure instrument comprise four elements with multiple dimensions (Table 3.1).

The 5-stage instrument aims to assess specific disclosure skills of the learner in response to the patient's five stages of grief. This rating scale comprised six elements with multiple dimensions (Table 3.2).

All elements and dimensions of both instruments were scored on a seven-point scale (1 being extremely ineffective, four being neutral, and seven being extremely effective). Given that two subjects spoke to the patient in the PACU together, it was intended that the subject's combined performance skills would be rated. The video recordings of the first six sessions were rated independently using the BARS for disclosure and 5-stages instruments and then discussed extensively to clarify the meaning of specific items on the rating scale and to improve agreement between the raters. After this rater training period, video recordings of the next 15 sessions were rated similarly. After each rater independently completed his assessment, a second step was taken to attempt to reach consensus for each element and dimension.

Table 3. 1 – BARS for Disclosure Instrument - elements and dimensions (reproduced with permission from the Journal [Attachment I])

ELEMENT 1. ESTABLISHES AN APPROPRIATE SETTING/ENVIRONMENT
Optimizes environment for conversation
Commits to respect the patient understanding
Explores concerns and expectations
ELEMENT 2. ENGAGES WITH PATIENT
Brings personal caring and humanity to the conversation
Acknowledges and responds to patient's emotions
Conveys compassion and empathy for the patient suffering
Aligns with patient's perspective
Listens actively and patiently
Uses simple and straightforward language
Facilitates discussion through verbal and non-verbal techniques
ELEMENT 3. DISCLOSURE AND APOLOGY
States clearly the facts as they are known at the present
Sincerely apologize in an appropriate manner
Discusses the adverse event as it impacts in patient's care
Checks the patient's understanding of the information provided
ELEMENT 4. HELPS PATIENT TO ACHIEVE OR SUSTAIN AN APPROPRIATE APPROACH TO THE EVENT
Assures that the event will be thoroughly investigated and that all facts will be communicated as they become known
Responds to patient's needs
Assesses whether the existing clinical relationships can be maintained and offers alternatives if appropriate
Offers support services
Explains what will be done to prevent similar events in the future

Raters score each component (element or dimension): 1 (extremely ineffective), 2 (consistently ineffective), 3 (mostly ineffective), 4 (neutral), 5 (mostly effective), 6 (consistently effective), 7 (extremely effective).

Table 3. 2 – 5-Stages Instrument - elements and dimensions (reproduced with permission from the Journal [Attachment I])

ELEMENT 1. POSTURE TOWARDS PATIENT
Assumes a comforting posture
Has an empathetic attitude
Acknowledges and responds to patient's emotions
Uses simple and straightforward language
Listens actively and patiently
Aligns with the patient's perspective
ELEMENT 2. DEALING WITH DENIAL
Respects patient's denial
States clearly the facts as they are known at the present
Checks the patient understanding of the information provided
ELEMENT 3. DEALING WITH ANGER
Acknowledges patient's anger
Respects patient's anger
Apologizes sincerely
ELEMENT 4. DEALING WITH BARGAINING
Respects patient's bargaining
Agrees to help solve the problem
Assures that the event will be thoroughly investigated and that all facts will be communicated as they become known
Assesses whether the existing clinical relationships can be maintained and offers alternatives if appropriate
Offers support resources (with respect to bargaining)
ELEMENT 5. DEALING WITH DEPRESSION
Brings personal caring and humanity to the conversation
Responds to patient's emotional needs
Offers appropriate support
ELEMENT 6. DEALING WITH ACCEPTANCE
States a plan
Maintains a commitment

Raters score each component (element or dimension): 1 (extremely ineffective), 2 (consistently ineffective), 3 (mostly ineffective), 4 (neutral), 5 (mostly effective), 6 (consistently effective), 7 (extremely effective).

3.2.6 Statistical analysis

Statistical Package for the Social Sciences (SPSS) 17.0™ (Chicago, Illinois) was used for all statistical analyses. To determine the interrater-reliability, we calculated the Cohen's kappa coefficient with linear weighting for each session, overall training and overall study. The agreement was considered moderate for coefficients between 0.40 and 0.60, substantial for coefficients from 0.61 to 0.80 and excellent for coefficients above 0.80.[76-78] Internal validity was demonstrated with Spearman rho correlation coefficient.

Performances were reported with mean (SD) and skewness coefficients of the elements and dimensions. Spearman ρ correlation coefficient was used to determine changes in the impact of each dimension on the correspondent element.

All tests were two-tailed and a $P < 0.05$ was considered significant.

3.3 Results

3.3.1 Interrater Agreement

Interrater reliability coefficients during the training period varied between substantial and excellent (0.7-1.0). The overall agreement for independent rating during the training period was substantial (Cohen's κ coefficient, 0.75). Following the independent rating for each session, discussion between the raters to reach consensus was then attempted. Ratings were changed in 71% of the cases but in only 32% by more than two units of the 7-point scale.

The interrater Reliability for the independent assessment during the study varied between moderate and excellent (0.45-0.9). The overall agreement for the study period was substantial (0.70).

3.3.2 BARS Disclosure Performance Assessment

As seen in Table 3.3, the mean performance scores obtained for elements within the BARS for disclosure instrument ranged between 4.20 and 4.47. The scores obtained for each element and dimension and the *P* value of the correlation between each dimension and the correspondent element are also presented in Table 3.3. All dimensions had a significant correlation coefficient with the correspondent element except dimension 6 (uses simple and straightforward language) on element two (engages with patient).

Table 3. 3 – BARS for Disclosure Instrument scores for 15 subjects (elements and dimensions) and p-value of the correlation between each dimension and its corresponding element (reproduced with permission from the Journal [Attachment I])

ELEMENT OR DIMENSION	OVERALL SCORE MEAN+/-STANDARD DEVIATION (SD)/SKEWNESS	*P*-VALUE OF CORRELATION WITH CORRESPONDENT ELEMENT
Element 1. Establishes an appropriate setting/environment	**4.47+/-0.99/+**	
Optimizes environment for conversation	4.80+/-0.86/-	0.000*
Commits to respect the patient understanding	4.40+/-1.35/-	0.003*
Explores concerns and expectations	4.40+/-1.24/-	0.002*
Element 2. Engages with patient	**4.27+/-1.10/+**	
Brings personal caring and humanity to the conversation	4.73+/-1.10/-	0.000*
Acknowledges and responds to patient's emotions	4.47+/-1.24/-	0.000*
Conveys compassion and empathy for the patient suffering	4.40+/-1.24/-	0.002*
Aligns with patient's perspective	4.33+/-1.34/+	0.000*
Listens actively and patiently	4.90+/-0.99/-	0.000*
Uses simple and straightforward language	4.06+/-1.22/+	0.090
Facilitates the discussion through verbal and non-verbal techniques	4.80+/-1.20/-	0.001*
Element 3. Disclosure and apologize	**4.40+/-1.20/+**	
States clearly the facts as they are known in the present	4.07+/-1.48/+	0.008*
Sincerely apologize in an appropriate manner	4.87+/-1.40/-	0.000*
Discusses the adverse event as it impacts in patient's care	4.00+/-1.36/+	0.026*
Checks the patient's understanding of the information provided	2.60+/-0.63/+	0.004*

Element 4. Helps patient to achieve or sustain an appropriate approach to the event	**4.20+/-1.39/-**	
Assures that the event will be thoroughly investigated and that all facts will be communicated as they become known	3.93+/-1.57/+	0.002*
Responds to patient's needs	4.40+/-1.24/-	0.035*
Assesses whether the existing clinical relationships can be maintained and offers alternatives if appropriate	2.93+/-1.57/+	0.001*
Offers support services	4.60+/-1.63/-	0.023*
Explains what will be done to prevent similar events in the future	4.00+/-1.36/+	0.000*

*Statistically significant

3.3.3 Five-Stage assessment

The overall scores obtained with the 5-stage instrument ranged from 3.73 to 4.46. The scores obtained for each element and dimension and the *P* value of the correlation between each dimension and the correspondent element are presented as Table 3.4. All dimensions had a significant correlation coefficient with the corresponding element.

Specific actions within each dimension were also measured (Table 3.4).

Table 3. 4 – 5-Stages Instrument scores (elements and dimensions), specific actions and *p*-value of the correlation between each dimension and its corresponding element (reproduced with permission from the Journal [Attachment I])

ELEMENT OR DIMENSION	OVERALL SCORE MEAN+/- SD/SKEWNESS	*P*-VALUE OF CORRELATION WITH CORRESPONDENT ELEMENT	SPECIFIC ACTIONS MEASURED
Element 1. Posture towards patient	**4.46+/-0.86/-**		
Assumes a comforting posture	4.80+/-0.86/-	0.042*	13% sat down 13% kept their arms crossed
Has an empathetic attitude	4.80+/-1.20/-	0.000*	87% introduced by name and position
Acknowledges and responds to patient's emotions	4.67+/-1.05/-	0.000*	
Uses simple and straightforward language	4.06+/-1.22/+	0.047*	40% used medical jargon
Listens actively and patiently	4.90+/-0.99/-	0.002*	
Aligns with the patient's perspective	4.33+/-1.34/+	0.000*	
Element 2. Dealing with denial	**3.73+/-1.10/+**		
Respects patient's denial	4.40+/-1.35/-	0.000*	27% validated the emotion
States clearly the facts as they are known in the present	4.07+/-1.48/+	0.000*	27% stated an untruth 33% speculated on another explanation
Checks the patient understanding of the information provided	2.60+/-0.63/+	0.035*	
Element 3. Dealing with anger	**4.40+/-1.12/+**		
Acknowledges patient's anger	4.47+/-1.24/-	0.006*	60% labeled and validated the emotion

Respects patient's anger	4.33+/-1.17/-	0.000*	13% told the patient to calm down 7% got angry with the patient
Apologizes sincerely	4.87+/-1.40/-	0.000*	33% apologized once 60% apologized twice or more 33% said they were sorry that the patient felt that way 40% said they were sorry that the adverse event has happened 13% took team responsibility 13% blamed others implicitly 20% blamed others explicitly
Element 4. Dealing with bargaining	**3.93+/-1.27/+**		
Respects patient's bargaining	3.93+/-1.39/-	0.000*	33% ignored
Agrees to solve the problem	4.00+/-1.36/0	0.000*	20% postponed decision
Assures that the event will be thoroughly investigated and that all facts will be communicated as they become known	3.93+/-1.57/-	0.000*	
Assesses whether the existing clinical relationships can be maintained and offers alternatives if appropriate	2.93+/-1.57/+	0.006*	
Offers support resources	4.07+/-1.86/-	0.004*	20% offered social support

Element 5. Dealing with depression	**4.26+/-1.16/-**		
Brings personal caring and humanity to the conversation	4.73+/-1.10/-	0.003*	
Responds to patient's emotional needs	4.40+/-1.24/-	0.000*	
Offers appropriate support	4.60+/-1.63/-	0.002*	
Element 6. Dealing with acceptance	**4.06+/-1.33/-**		
States a plan	3.93+/-1.28/+	0.007*	33% obtained consent 40% agreed to follow up
Maintains a commitment	4.46+/-1.68/-	0.003*	20% didn't leave without requesting additional support

3.4 Discussion

The next generation of physicians must be prepared to properly disclose adverse events and our educational system misses opportunities to instruct medical trainees in disclosure.[70] Disclosures are emotionally charged conversations that require advanced communication skills.[79]

We have demonstrated a structured mixed-realism exercise to engage Anesthesiology trainees in disclosure education. The combination of (1) immersing the trainees in a high-fidelity environment using mannequin simulation where the adverse event occurred and (2) disclosing to a SP who (3) discretely traverses through the Kübler-Ross five stages of grief and (4) debriefing the specific skills required in each stage during a disclosure discussion is the anatomy of this structured approach. By experiencing the evolution of the adverse event, we intended for the trainees to have broader understanding of the context, consequences, and issues than if they were given a paper case stem before speaking with the standardized patient. Using a semi structured 5-stage grief response for the SP allowed a clear observation of specific skills of the trainee in each of these discrete areas.

We have also developed and begun to validate a new assessment instrument combining a

BARS for disclosure and 5-stage assessment instrument. The BARS instrument provided information on the general quality of the disclosure, whereas the 5-stage instrument provided an evaluation of the specific skill behaviors to the patient's grief response. Although there were limitations of the rating instruments, both instruments showed reasonable reliability and sensitivity for their purpose. When the raters did not agree (lower κ coefficients), the issue seemed to be related to behaviors missed by one of the raters, to different perceptions of responsibility and/or honesty, to emotionality of raters (as has been demonstrated in patients,[80] rater's interpretation of what was said often appeared to be more important than the actual words) and to the difficulty in rating the most highly subjective dimensions such as the sincerity of an apology. It was also demonstrated that the raters were easily able to close the gaps with a brief discussion while reviewing the video of the educational session to reach a consensus score.

A sample of anesthesia residents engaged in disclosing an adverse event to a SP showed quite a number of skillful actions and behaviors. Overall, residents were mostly effective in optimizing the environment for the conversation, listening actively and patiently, bringing personal caring and humanity to the conversation, apologizing and offering support services. They do not, however, consistently check the patient's understanding, assess the maintenance of clinical relationships, define a plan for the problem, or convey future prevention strategies.

Trainees performed well introducing themselves properly and validating patient's feelings, as alignment with patient's perspective and the respect for the patient's understanding are essential for the reestablishment of trust in an injured patient-physician relationship.[81] Few sat down during conversation despite the possibility that this sent nonverbal messages that were neither desirable nor intended.

Although almost all of the Anesthesiology trainees apologized some of the apologies were nonspecific (e.g. "sorry that you feel that way"). One possible explanation for their reluctance is confusion over whether the adverse event was attributable to a technical error of their own. Perhaps, they view the concept of responsibility as that of an individual and not of a team or specialty. In addition, they may have assumed that by apologizing, they would be accepting blame. Physicians are particularly concerned that disclosure may increase the chances of being sued - this is why many physicians never admit their mistakes or accept their responsibility.[82,83] Rightfully, until formal analyses have been completed, it is usually uncertain as to the exact events that lead to an adverse event.[79] Nonetheless, expressing sympathy in the form of an apology regardless of the blame is widely recognized as a desirable component of the disclosure discussion.

There were a number of limitations to our study. First, as in all simulations, it is impossible to know how realistic and engaged the subjects felt and the degree of their treatment of the case *as if* it was real.[84] Although we went to great lengths to make the fidelity of the OR experience and the PACU conversation with the SP as high as we could, some subjects could have viewed the occurrence of awareness as unrealistic, the inappropriate conversation as unlikely, or the mannequin patient unable to really hear the conversation. During the debriefings, the participants expressed quite the opposite, but even they might not accurately perceive the effect of their degree of suspension of disbelief on their performance in the disclosure conversation. Second, we have developed only one exercise using mixed realism as a disclosure tool. Although this exercise was very successful, others will have to be developed and demonstrated to establish this technique as a *best practice*. Third, we made no attempt to study the educational effectiveness of the exercise. In future work, we can test the learning in subsequent mixed-realism cases to assess learning as compared with groups having other forms of disclosure education. Furthermore, studies of the effectiveness of the learning in a naturalistic environment are possible. Fourth, all the participants were Anesthesiology residents from three different hospitals limiting the generalizability of the descriptive results to other specialties and institutions. Fifth, certain limitations of the rating instruments are apparent. Because the raters in this study were investigators, a potential bias exists, especially with respect to the ease of achieving consensus ratings. Moreover, the training period might not be representative because the investigators were, of course, already familiar with the instruments. Further validation of the instrument using other cases, more raters, and more subjects from a variety of fields and levels of experience will be the topic of future work.

A structured technique for learning disclosure through simulation-based exercises, debriefing, and assessment of skills may contribute to improving physician's willingness and ability to engage in these difficult conversations.

Chapter 4: Non-technical skills progression during Anesthesiology residency in Portugal: the impact of a National Pedagogical Plan

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4.1 Introduction

In medical education, students need to acquire the necessary skills to treat and care for patients. Due to the complexity of patient care, namely in the field of Anesthesiology, where clinicians have to face with emergencies and multidisciplinary teams, knowledge is not limited to technical procedures but also include a behavioral component such as the ability to communicate with other healthcare providers or patients, teamwork, situation awareness, and decision making.[16,85] Thus, the main objectives of medical education include not only the acquisition of theoretical knowledge with scientific evidence, technical and non-technical, but also behavioral competencies.[86] During medical education, students are supposed to comprehend their clinical self-evolution, increase their awareness of error and their gaps, and develop their behavioral skills.[87]

Simulation could replace real experiences, in an immersive and interactive environment, allowing participants to learn and acquire skills in a controlled way with the guarantee of patient safety.[88] With simulation, real patients are replaced by artificial models, live actors, or virtual reality patients, aiming to replicate patient care scenarios in a realistic environment.[8] Due to the impact in the learning course and in retention time, medical simulation allows for an improvement of this process.[89] Moreover, simulation will contribute to filling technical and non-technical lacunae, both belonging to the process of clinical evolution.[8]

Although some reports state that simulation can enhance critical thinking and behavior, data on how these skills can be transferred to real patients is lacking, and therefore more research in this field is needed.[90]

The development of a National Pedagogic Plan by the Biomedical Simulation Centre from Centro Hospitalar e Universitário de Coimbra (BSC-CHUC) in Portugal has the objective of integrating a simulation-based training for Anesthesiology residents, as part of their training, including non-technical skills.

This study aimed to evaluate how a simulation program applied to Portuguese Anesthesiology residents, over the four years of residency, could impact the acquisition of behavioral competencies by the students. This evaluation was performed with a new instrument, a questionnaire, that was created to self-assess aspects of anesthetic practice that would be difficult to evaluate by direct observation, such as the ability to manage a crisis.

Data were collected using confidential questionnaires given before and after each simulation module corresponding to the specific year of residency, including individual and team learning, behavior, and course evaluation questions. Thus, we will be able to identify gaps in knowledge and practice that are fundamental motivators to continuing professional development. The evidence suggests that improved accuracy of self-assessment leads to improved learning outcomes. This may be relevant to the emerging field of simulation-based learning.[91]

In this paper data related to behavior will be presented. This belongs to a Kirkpatrick level two since we will be able to demonstrate that simulation changed the performance outside of the clinical environment.[16]

4.2 Methods

4.2.1 Study design

This was a prospective observational study designed to evaluate how the Anesthesiology Simulation Pedagogical Plan from BSC-CHUC impacted the behavior of Portuguese Anesthesiology residents. To achieve this goal, questionnaires were applied before and after each simulation module. These questionnaires were designed according to the pedagogical contents of each year of the ARP.[53,92]

Questionnaires included questions regarding learning, behavior, and evaluation of the pedagogical content of each simulation course. Behavioral questions were similar throughout the four years (horizontal questionnaire – Table 4.1) and were performed before and after each simulation module. The complete questionnaires are included in Appendix I.

Table 4. 1 – Horizontal questionnaire applied over the four years of the ARP. These questions were performed pre- and post-simulation courses each year (reproduced with permission from the Journal)

Question	
Q5	I have been in situations that I could not deal with without help
Q6	I ask for help
Q7	I feel the need for support
Q8	I make mistakes
Q9	It is difficult for me to report the mistakes I make
Q10	I do not feel prepared for the responsibility I have
Q11	I do not have enough knowledge for the responsibility I have
Q12	I do not have enough training for the responsibility I have
Q13	I do not have enough experience for the responsibility I have
Q14	I feel bad when I ask for help
Q15	When I disagree with the consultant anesthesiologist's opinion, I do not express that position
Q16	The behavioral component is crucial in the clinical setting

4.2.2 Questionnaires development and validation

The draft questionnaire was designed by two anesthesiologists with experience in simulation. To ensure face and content validity, the items were reviewed for syntax and appropriateness by a panel of five experts with expertise in the area of simulation in Anesthesiology training**.** The final questions were evaluated by a behavioral psychologist for the rejection of confounder items.[93]

The questionnaires were administered to 30 participants of the Anesthesiology Simulation Pedagogical Plan from BSC-CHUC, in two pilot-courses. These participants were Anesthesiology residents from CHUC belonging to the target group of the questionnaires.
Internal reliability was estimated for the overall questionnaires using Cronbach´s alpha coefficient. The values obtained for each year's questionnaire were: 0.86 for year I, 0.84 for year II, 0.87 for year III, and 0.89 for year IV, indicating high internal consistency of all questionnaires.

4.2.3 Setting and participants

This observational study was conducted in Portugal, from 2011 to 2018, at BSC-CHUC. The participants were Anesthesiology residents that attended the simulation courses at BSC-CHUC. Inclusion criteria: all residents enrolled in Anesthesiology simulation courses at BSC-CHUC.

Ethical approval for this study (Ethical Committee Nº 171/CES) was provided, retrospectively, by the Ethical Committee from CHUC, Coimbra, Portugal (Chairperson Prof. Doutor João Pedroso de Lima) on 18 July 2019. Written informed consent has been waived by the Ethical Committee (Attachment II).

4.2.4 Variables and methods of assessment

All variables were collected on an anonymized database specifically designed for the study. The source of all variables were the specific questionnaires applied before and after each simulation course. Answers to Q5, Q6, Q7, and Q8 were given on a three-point Likert Scale (0-never; 1-few times; 2-many times) and the remaining on a five-point Likert Scale (0-strongly disagree; 1-partially disagree; 2-no opinion; 3-partially agree; 4-strongly agree).

4.2.5 Bias

Not applicable.

4.2.6 Quantitative variables

All collected variables were quantitative.

4.2.7 Statistical methods

Non-parametric statistical methods were used. All analyses were performed with the Wilcoxon test. Values are presented as mean (95% confidence intervals). SPSSv20 (IBM, United States of America (USA)) was used. Tests were considered significant at $\alpha<0.05$ significance level (two-sided).

4.3 Results

A total of 340 answered questionnaires were included in the study. The first-year course was concluded by 76 residents, the second year by 89, the third year by 82, and the fourth year by 93 residents. The mean age of the residents, in the first year, was 26.5 years with a minimum of 25 years and a maximum of 29 years.

Figures 4.1, 4.2, 4.3, and 4.4 represent the self-assessment of the residents before and after each simulation course in the first, second, third, and fourth year, respectively.

In the first year (Figure 4.1), the simulation course allowed the residents to gain more confidence to ask for help (Q6); they acknowledged they made more mistakes (Q8), and they felt less prepared and with less experience towards their responsibility (Q10 and Q13). Students felt an increase in the training for their responsibility (Q12) and more students assumed to feel bad when asking for help (Q14) Nevertheless, they were more confident to share their opinion (Q15) and attributed more importance to the behavioral component (Q16).

After the second-year course (Figure 4.2), students recognized to face more situations that they could not deal with without help (Q5). Nevertheless, they asked for help less often (Q6) and also felt the need for support less (Q7). Regarding their responsibility, after the simulation course, they felt that they were less prepared (Q10), did not have enough knowledge (Q11) but had more experience (Q13). Similarly, to the first-year course, the behavioral component gained more importance after the simulation course (Q16).

The third year of the simulation course provided the Anesthesiology residents with the ability to ask for help less (Q6). However, they felt difficulty to report the mistakes they made (Q9). Although feeling more prepared for their responsibility (Q10), the students acknowledged that they had less knowledge, less training, and less experience (Q11, Q12, and Q13). The course decreased the fact that they felt bad when asking for help (Q14). The behavioral component gained even more importance after this third-course year (Q16).

The last simulation course was the one that impacted more on the students' self-evaluation. There was only one answer that was not changed with the course (Q11, regarding the knowledge for responsibility).

Figure 4.4 represents the global evolution from the pre-year I course to post-year IV course. All differences are statistically significant.

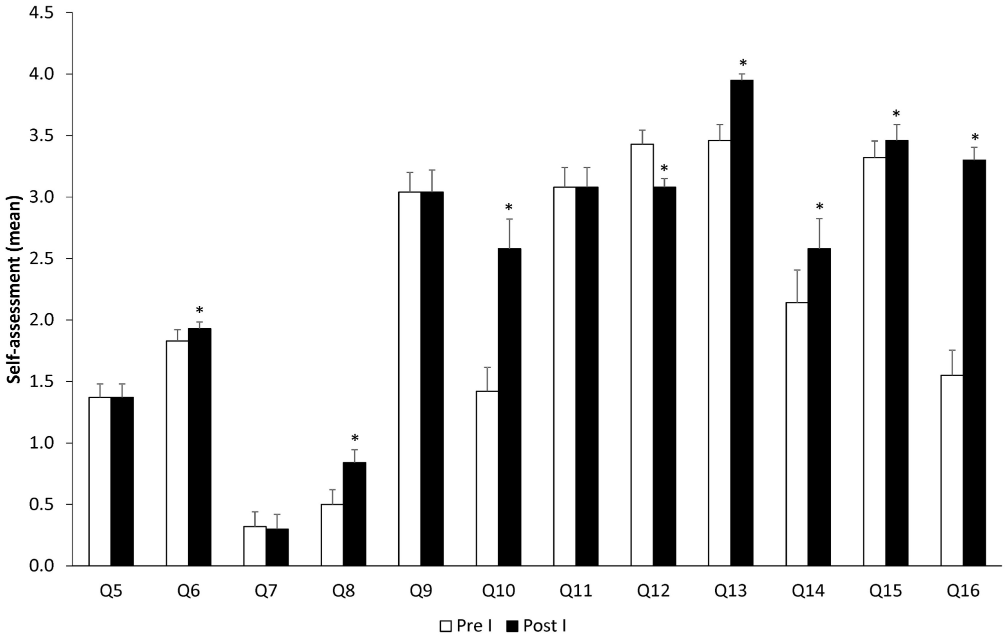


Figure 4. 1 – Evolution over time comparing pre-course and post-course - year I. *p<0.05 (reproduced with permission from the Journal).

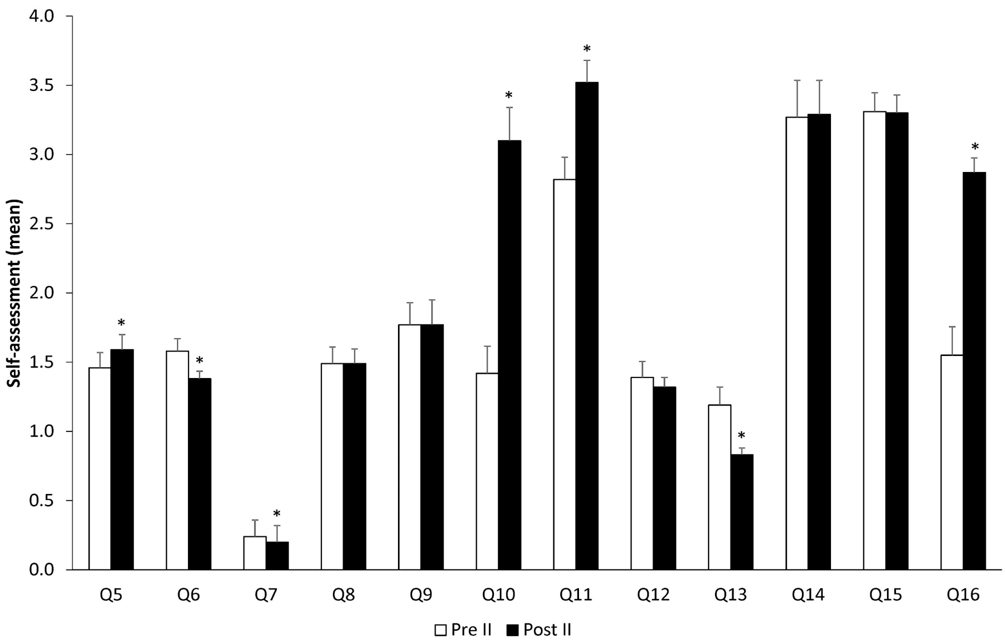


Figure 4. 2 – Evolution over time comparing pre-course and post-course - year II. *p<0.05 (reproduced with permission from the Journal).

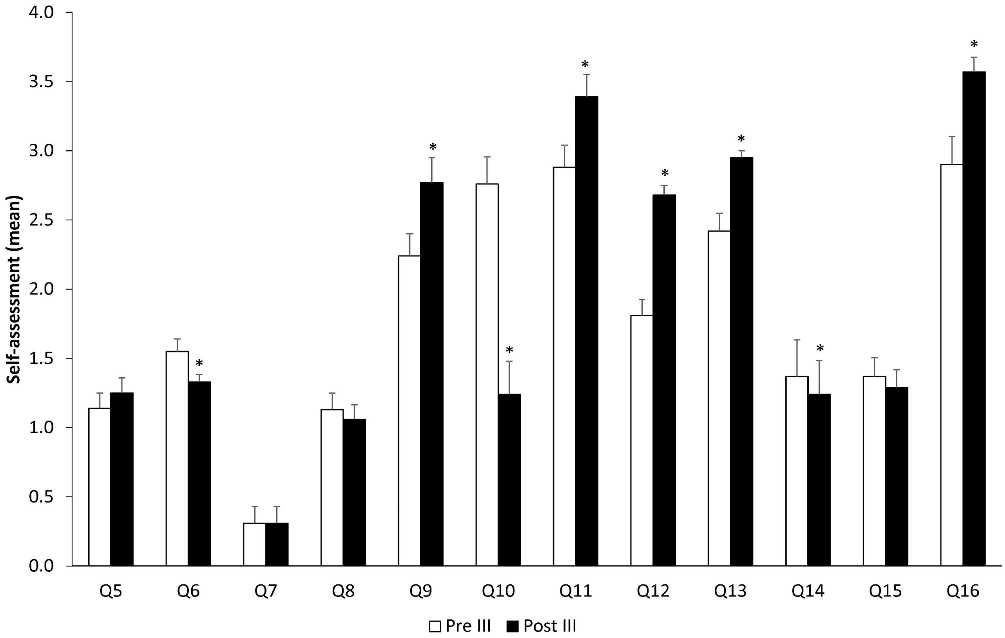


Figure 4. 3 – Evolution over time comparing pre-course and post-course - year III. *p<0.05 (reproduced with permission from the Journal).

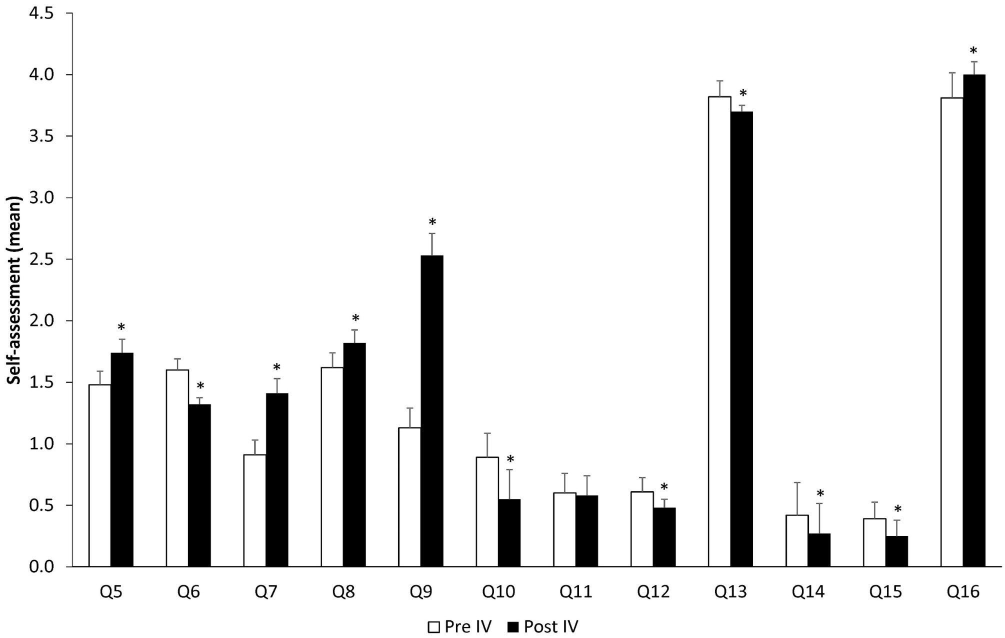


Figure 4. 4 – Evolution over time comparing pre-course and post-course - year IV. *p<0.05 (reproduced with permission from the Journal).

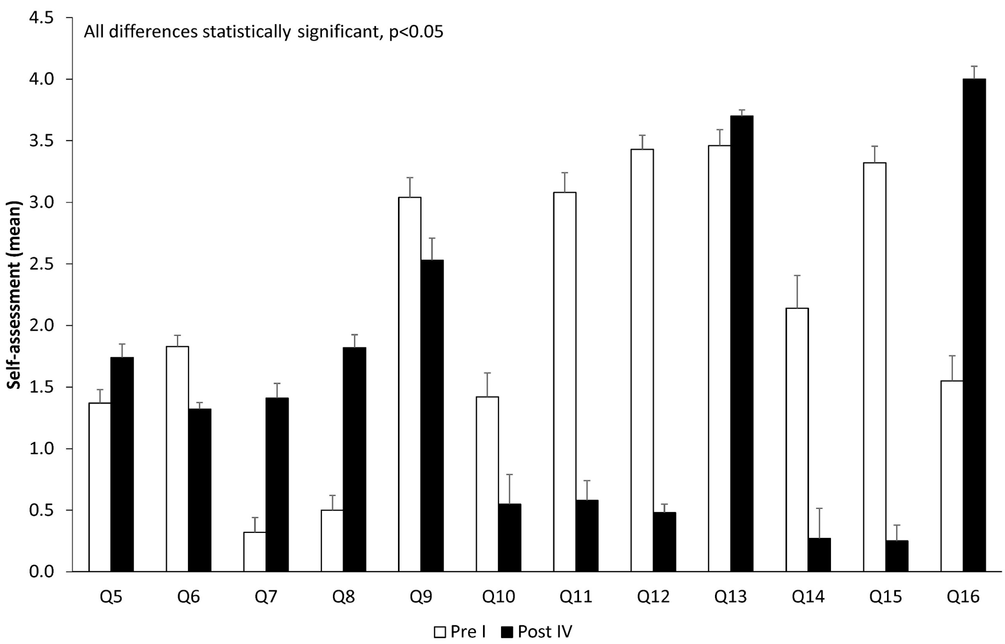


Figure 4. 5 – Global evolution of the simulation courses. All differences are statistically significant (reproduced with permission from the Journal).

4.4 Discussion

Medical error is an important cause of death and some errors are attributed to skills such as communication and leadership.[94,95] Simulation activities, beyond their known impact on the learning of technical skills in a safe environment, are a powerful form of concrete and active experiences with a high retention level that potentially changes behaviors (leadership, communication, and resource management), ultimately increasing patient safety.[8,96,97] Therefore, they can be considered a bridge between theoretical lessons and clinical practice, helping junior doctors to deal with emergencies.[98]

However, the optimal use of simulation in Anesthesiology education programs is not so clear.[16] In our National Pedagogic Plan from the BSC-CHUC, a simulation course was proposed to all Portuguese residents in Anesthesiology, designed according to the curricular goals set forth by the Portuguese College of Anesthesiology and had a wide participation showing the interest of residents in the study.

Using questionnaires, we aimed to contribute to better understand the role and importance of simulation in non-technical skills that are fundamental for the correct and safe practice in Anesthesiology.

Taken together our results showed that the simulation courses positively impact the learning process of the students.

The "ask for help" (Q6) was one of the questions whose answer changed after every simulation course. Nevertheless, only in the first year there was an increased self-perception regarding the need for help. This suggests that the first year allows the students to gain conscientiousness about their limitations. Another important point to underline is the increase in the "need for support" (Q7) in the fourth year. Indeed, the fourth year was the one where students felt more need for support (Q7), suggesting that this feeling increased after being exposed several times to simulation scenarios.

Regarding Q8, it was very interesting to observe that first-year residents were the ones that perceived to make fewer mistakes, either because they still did not have the opportunity to do them or because they did not have enough knowledge to realize them. On the contrary, the 4th year was the most experienced and knowledgeable, and when students recognized to make more mistakes. This suggests that the more we know the more we can self-criticize. Also, experience and autonomy increased in the later years, and this increased the likelihood of acknowledging errors. Notwithstanding, only during the third and fourth years, students felt more difficulty to report their own mistakes (Q9).

A common point that may explain the answers to these questions is the fact that first-year students are always accompanied, and therefore feel more comfortable. In the second year, students gain more awareness of their limitations due to the increase in experience and knowledge. In the third year, the know-how and the confidence increase considerably. Finally, in the last year, the fourth, they face critical situations that they are not able to solve on their own and gain consciousness regarding errors and, consequently, the need for help.

In the questions focusing on the residents' perception about responsibility, it is important to underline that only after the fourth year the students acknowledged to be more prepared (Q10), more trained (Q12), and to have more experience (Q13) after the simulation training. The positive impact on knowledge occurred after the second and third years (Q11). The preparedness acknowledged by the residents in the later years is very important and critical situations during the simulation courses contributed to this preparedness. In the third-year students have to face situations with more responsibility and in a more autonomous manner. Also, in the third year, the level of difficulty increases, and therefore students need to go through an adaptation process. If we interpret the results regarding experience based on simulation training, we may speculate that students felt that they needed more simulation training during the residency.

Regarding communication skills, the main differences were the increase in the "ask for help" (Q14) and opinion expression (Q15) after the 1st course, with opposite results in the last year: decrease of both. These results suggest that students acquired more confidence in themselves, recognizing both a higher need to ask for help and a higher confidence to express their opinion to the consultant anesthesiologist over the years. These results can be related to the fact that students felt more familiar with the department, more confident, more patient, more aware of what matters – they were not as concerned as before regarding what others may think about them. As the residency progresses, students understand that asking for help is a basic component of the general clinical practice and specifically of Anesthesiology. Communication skills are fundamental and impact numerous health outcomes, including trust in clinicians, satisfaction, and even patient and family quality of life.[50,99,100] Therefore, training in communication skills is crucial to improve them.[101] Our results show that the simulation courses positively impact the communication skills of Anesthesiology residents. The simulation scenario also helps students to understand that the leader is not necessarily the older person but the one that better faces and solves specific situations, at specific moments. Everyone´s opinion is a valuable input for every situation, and a lack of leadership could be highly detrimental to performance during a critical situation.[102]

Finally, the global question about behavior in critical situations clearly showed that although the increase during the first simulation course is a significant behavioral component, it gained more importance throughout the residency. One possible explanation may be that at the beginning of training there was a strong focus on lack of knowledge and skills, and less focus in behavior. Also, behavior was less tested in the first years since at that time residents are not alone and do not make clinical decisions. Given this implies less leadership, non-technical skills were not considered important.[102] However, and over the years, students had no doubts about the impact of behavior in critical situations, which is clearly reflected on the fourth-year being the one that attributed more importance to behavioral questions. This year was the one with the most experience and that faced a higher number of situations that showed them the importance of non-technical skills. Also, they have had the opportunity to participate in courses and congresses that have enhanced these characteristics, and therefore are better able to understand these skills as crucial in the clinical setting.

Approaches including teamwork, mistakes, communication, and need for help have been considered a priority in the simulation setting since they can have an impact on patient safety. Therefore, including these approaches in simulation will allow to identify latent threats in a clinical environment.[97,103]

Following the success of this program, a broader project was developed, under the coordination of the Portuguese Medical Association. This project aimed to create a national training program recommended to Anesthesiology residents and was designed in cooperation with all Portuguese simulation centers.

The main limitation of this study is the fact that it was only based on students´ self-evaluation. Therefore, the results of the simulation training were only presented from the students' point of view. An independent evaluation should be performed to validate the results from other points of view. Another limitation is the fact that only residents that voluntarily enrolled in the program were included: it was not randomized and that could have influenced the results since the participants can be more prone and willing to learn. Finally, the simulated environment could not fully capture the real behavior that would occur in a real environment. However, this limitation is inherent to all simulation training.

4.5 Conclusion

This study shows that a simulation program positively impacts non-technical/behavioral issues, influencing the learning process in Anesthesiology, corresponding to a Kirkpatrick level 2. Further studies will be performed to confirm the ability to recognize the crucial importance of non-technical skills in the clinical setting.

Chapter 5: National Pedagogical Plan in Anesthesiology: evaluating the impact of simulation training during residency in Portugal

This chapter is submitted as an original paper Matos F. M., Martins M. R., Martins I., Norte G. The impact of simulation during residency: the example of the Portuguese National Pedagogical Plan in Anesthesiology, *submitted*.

5.1 Introduction

Medical simulation is defined as a recreation of clinical situations aiming to improve, test, or evaluate the knowledge of systems and human actions.[8] Simulation education has been a tendency and is now recognized as part of medical education mainly due to the decrease in opportunities to practice in real-world situations and concerns about patient safety.[8,16] The development of medical simulation, with new educational models and the improvement in simulators enables the training of the theoretical, technical, and behavioral components without endangering the patient.[88,104]

In the Anesthesiology context, teams are composed of members with different levels of knowledge, experience, and skills who work in an environment with high technological complexity in many cases without prior mutual knowledge.[105] Moreover, the challenging technical procedures in Anesthesiology are increasing and, therefore can result in procedure-related complications, especially if the anesthesiologist is not properly trained.[104,106,107] Medical simulation in Anesthesiology has shown promising results regarding effectiveness.[104,108]

To bridge the gaps in Anesthesiology teaching and integrate the simulation as an educational reference tool, the Biomedical Simulation Centre from Centro Hospitalar e Universitário de Coimbra (BSC-CHUC), Portugal, provides an optional pedagogical plan (National Pedagogical Plan) to all Anesthesiology residents. This plan is composed of four simulation modules elaborated according to the curricular goals defined by the specialty college and in a team-oriented way.[53,109] Evaluation of simulation training as an educational tool is a challenge since there is a need for instruments for objective and reliable analysis. The Kirkpatrick classification is commonly used to grade the quality of evidence in education research based on the degree of behavioral changes that it impacts.[110] The classification system comprises four degrees: Evaluation of Reaction (level 1), Evaluation of Learning (level 2), Evaluation of Behaviour (level 3), and Evaluation of Results (level 4).[17] This study aimed to evaluate the evolution and the role, by self-assessment, of Portuguese Anesthesiology residents enrolled in the simulation program at BSC-CHUC over the four years of residency. This evolution was evaluated based on confidential questionnaires given in person, before and after each specific simulation module, including individual and team learning, behavior, and course evaluation questions. Skills, knowledge, and attitudes are part of the clinical performance, and the presented study reports the technical component of the learning and training process.

Our hypothesis was that simulation courses, specifically on curricular goals defined by the Portuguese College of Anesthesiology, increase self-confidence and modulate learning at the different levels of training of the Portuguese Anesthesiology residents. We have also addressed the role of simulation courses in non-technical skills, as behavior and communication questions. These results were previously published. [111]

Although this work was conceptually performed based on anaesthesiology training, our study results would be transversal for any field of medical education. Thus, we aimed to explore the role of simulation in the change of individual and team learning that corresponds to a hierarchical grading of level 2 in the Kirkpatrick classification.[46] In this second level, the knowledge and skills acquired should be assessed, and pre- and post-course tests regarding the learner's perspective, as used in this study, could be a useful methodology.[110]

5.2 Methods

5.2.1 Study design

This prospective observational study was designed to evaluate the impact of the Anesthesiology Simulation Pedagogical Plan from BSC-CHUC in the self-assessment of confidence, behavior, and training of Portuguese Anesthesiology residents. Residents that participated in the optional simulation courses completed an in-person questionnaire before and after each simulation module that was designed according to the program contents of each year of the Anesthesiology Residency Program (ARP) (Table 5.1).[53]

Table 5. 1 – Programmatic content of each simulation module

Year I	• Basic pharmacology in Anesthesiology
	• Basic and advanced airway
	• Ventilation
	• Ultrasound in anesthesia
	• Central and peripheral cannulation using ultrasound
	• Neuraxial anesthesia and local anesthetics
	• Etiology and prevention of cardiorespiratory arrest
	• Basic Life Support
	• Advanced Life Support
Year II	• Leadership and health management
	• Difficult Airway management
	• Supraglottic and transcutaneous devices
	• Fibroscopy principles
	• Ultrasound in anesthesia
	• Ultrasound-guided regional blocks
	• Anesthetic approach to the burnt patient
Year III	• Assessment of a trauma patient
	• Massive hemorrhage management
	• Pathophysiology and management of Acute Respiratory Distress Syndrome
	• ARDS ventilation
	• Pathophysiology of sepsis
	• Management of a septic patient
	• Anatomy-physiological changes of pregnancy
	• Labour analgesia
	• Obstetric emergencies
Year IV	• Effective communication
	• ACRM
	• OR emergencies

Questionnaires, previously developed and validated, and translated to the English Language,[111] included questions about learning, behavior, and evaluation of each simulation course's pedagogical content. Learning questions were the same across the four years (horizontal questionnaire – Table 5.2).

Table 5. 2 – Horizontal questionnaire for evaluation over the 4 years of Anesthesiology Simulation Pedagogical Plan. These questions were performed pre-and post-simulation courses in each year of the residency in Anesthesiology.

Question	
Q1	How do you assess your training for critical events in the Operating or Emergency Room?
2	In your opinion, how important is...
Q2.1	...airway management?
Q2.2	...ventilatory monitoring?
Q2.3	...cardiac monitoring?
Q2.4	...neuromuscular block monitoring?
3	How do you evaluate your training...
Q3.1	...in difficult airway management?
Q3.2	... in advanced life support?
Q3.3	...for emergencies in your clinical practice?
Q3.4	...in crisis resource management?
Q3.5*	...in obstetric emergencies?
Q3.6*	...in trauma?
4.	How do you assess your expertise...
Q4.1	...in difficult airway management?
Q4.2	...in advanced life support?
Q4.3	...for emergencies in your clinical practice?
Q4.4	...in crisis resource management?
Q4.5*	...in obstetric emergencies?
Q4.6*	...in trauma?
Q17	Simulation team training is an important complement to the residency program
Q18	A regular simulation update plan should be defined
Q19	Simulation team training improves daily clinical practice
Q20	Simulation team training may have an impact on patients' clinical outcome

*Questions only apply to the 3^{rd} year questionnaire

5.2.2 Setting and participants

This study was an observational study conducted in Portugal, from 2011 to 2018, at BSC-CHUC. The same simulation courses of BSC-CHUC were offered, always as optional since February 2011.

Participants: Four participants were included in each section with the roles of senior fellow (1st help), fellow, and two residents, according to each scenario. Each scenario had an actor, instructor that set the scene for the simulation and assigns the roles. All residents were active in hot seats. The script of the scenarios was related to each module's content, described in Table 5.1, and representative ones are included as supplementary data (Additional file 1). Each scenario was preceded by a briefing that sets the scene for the simulation and assigns the roles. Participants should know who they are, where they are, and what their role is.

Participants were all Anesthesiology residents that participated in the optional simulation courses at BSC-CHUC, and this was the only inclusion criterion to participate in this study.

Simulator type: The simulators used were two iStan (CAE), one PediaSIM (CAE), one SimBaby (Laerdal), and one Noelle (Gaumard). All the performed modifications are specified in the scenario scripts (Additional File 1).

Simulation environment: All the scenarios were developed at the simulation center. Each scenario had all the settings, technical support, and equipment expected in the clinical environment. The simulation environment included 3 simulation rooms: an Operating Room that maintains all the atmosphere of a Surgery Room, a Post-Anesthetic Care Unit, and an Emergency Room or ward. The external stimuli were the continued clinical practice.

Simulation event/scenario: Annually, approximately 15 residents participated in each course, with the number of courses per year depending on the number of enrolled residents. Most simulations were conducted in groups with specific individual and group learning objectives. Adjuncts to simulation practice included moulage, media, and props. All the facilitators were Anesthesiology consultants with specific simulation instructor training (EuSIM course or Center for Medical Simulation - Harvard Medical School). Furthermore, all actors and standardized/simulated patients had an introductory simulators instructor course offered by the BSC-CHUC.

Instructional design: Simulation courses were performed during each specific year's first trimester, being integrated as part of the residency training. Participants had the opportunity to repeat each scenario.

Standards for participant performance were defined in alignment with the goals for each year of training designed by the Portuguese Board of Physicians and evidence-based information for each clinical event. Every situation that demanded special individual attention had one assigned instructor for follow-up.

Since every situation was integrated as part of the residency training, the difficulty is aligned with the goals for each year of training designed by the Portuguese Board of Physicians. To sustain the learning process, educational support and small lectures were given.

Feedback or debriefing: The source of feedback was a facilitator is a structured debriefing, following the scenario. Each scenario had a debriefing three times longer with two facilitators present at each debriefing. All debriefings were conducted following 3 phases: description, analysis, and application with take-home points.

5.2.3 Variables and method of assessment

All variables were collected on an anonymized database specifically designed for the study. The source of all the variables was the specific questionnaires applied before and after each simulation course. The collected variables were grouped in individual learning and simulation impact. Answers were given on an eleven-point Likert Scale (0-10, ranging from null to maximum) for individual learning questions and a five-point Likert Scale for simulation impact (0-strongly disagree; 1-partially disagree; 2-no opinion; 3-partially agree; 4-strongly agree).

5.2.4 Bias

The study was only based on students' self-assessment, which can constitute a source of bias due to intra-personal variability.

5.2.5 Quantitative variables

All collected variables were quantitative.

5.2.6 Statistical methods

Non-parametric statistical methods were used. All analyses were performed using the Wilcoxon test. Values are presented as mean (95% confidence intervals). Data analyses were performed using SPSSv20 (IBM, USA). Tests were considered significant at $\alpha<0.05$ significance level (two-sided).

5.3 Results

A total of 340 answered validated questionnaires were included in the study: the first-year course was completed by 76 residents, the second year by 89, the third year by 82, and the fourth year by 93 residents. The median age of the residents in the first year, was 26 years, with a minimum of 25 years and a maximum of 29 years.

All figures are divided into two panels: Panel A and Panel B. Panel A includes questions Q1-Q4.4 whose answers were given on an eleven-point Likert Scale (0-10, ranging from null to maximum) for individual learning assessment. Panel B includes questions Q17-Q20 whose answers were given on a five-point Likert Scale for simulation impact (0-strongly disagree; 1-partially disagree; 2-no opinion; 3-partially agree; 4-strongly agree). Since most results are statistically different only results without statistically significant differences are included in the results' description. For a better interpretation of the data, this section was divided into three parts: the comparisons between before and after each year simulation modules (part I) that are the results with less interference of the traditional education and the ones that better represent the effect of simulation courses; the comparisons between the post-simulation module and the pre simulation module of the following year (part II) that are the results which better reflects the learning and training process of the traditional education. The last section aggregates all of the results, comparing the results before the first simulation module with the last ones after the last simulation module (part III).

5.3.1 Pre-post comparisons of each year simulation modules

Figures 5.1, 5.2, 5.3, and 5.4 correspond to the pre-post comparisons of each year of the simulation courses: the year I, II, III, and IV, respectively.

In the first year, the self-assessment of learning following the simulation course was perceived as better than before attending the simulation course. (Figure 5.1 – Panel A and Panel B).

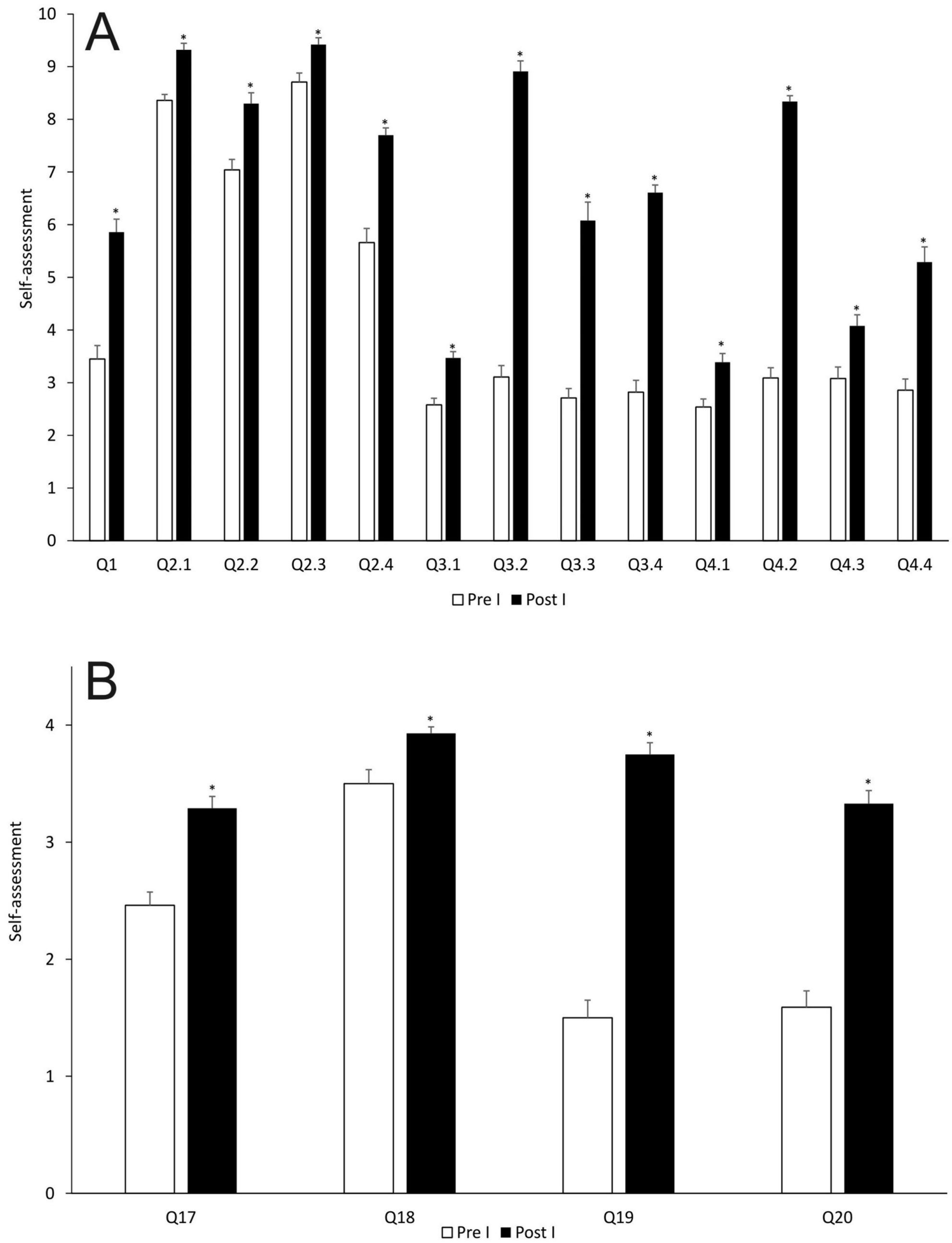


Figure 5. 1 – Evolution over time comparing pre-course and post-course - year I. Panel A: Questions Q1 – Q4.4. Panel B: Questions Q17-Q20. Mean ± 95% CI. *$p<0.05$

In the second year, the simulation course did not change how the residents evaluate their training regarding ALS (Figure 5.2, Panel A, Q3.2) neither in their opinion regarding a regular simulation plan update (Figure 5.2, Panel B, Q18): most of the residents partially agree that a regular simulation plan update should be defined.

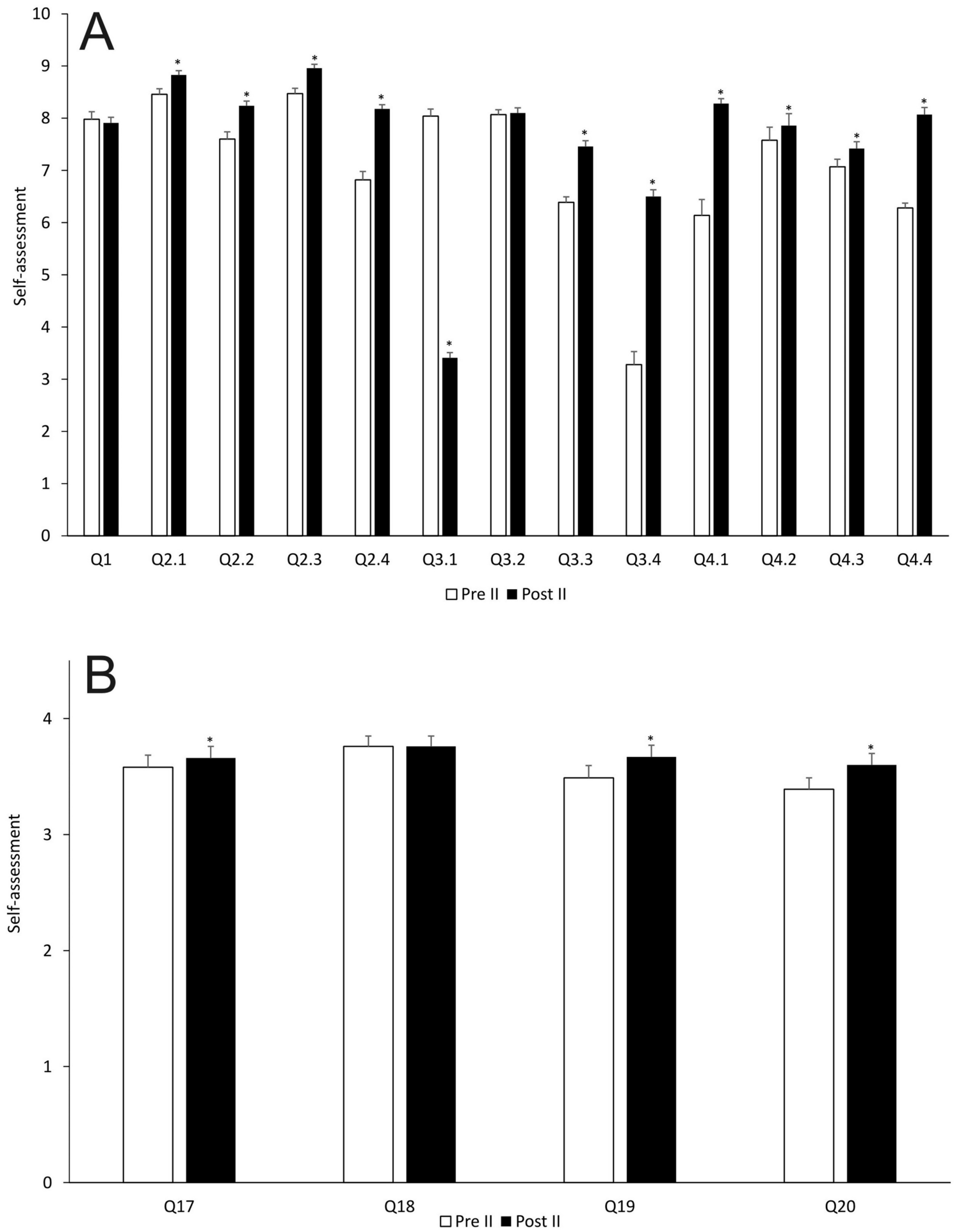


Figure 5. 2 – Evolution over time comparing pre-course and post-course - year II. Panel A: Questions Q1 – Q4.4. Panel B: Questions Q17-Q20. Mean ± 95% CI. *p<0.05

In the third year, the residents' opinion about the importance of neuromuscular block monitoring was the same before and after the simulation course (Figure 5.3, Panel A, Q2.4). Their difficult airway management expertise did not change during the simulation training (Figure 5.3, Panel A, Q4.1). Nevertheless, regarding these two last points, the mean of answers was approximately 8. Most of the residents agreed, before and after the simulation course, that a regular simulation update should be defined (Figure 3, Panel B, Q18) and additionally that the simulation team training improves everyday clinical practice (Figure 5.3, Panel B, Q19).

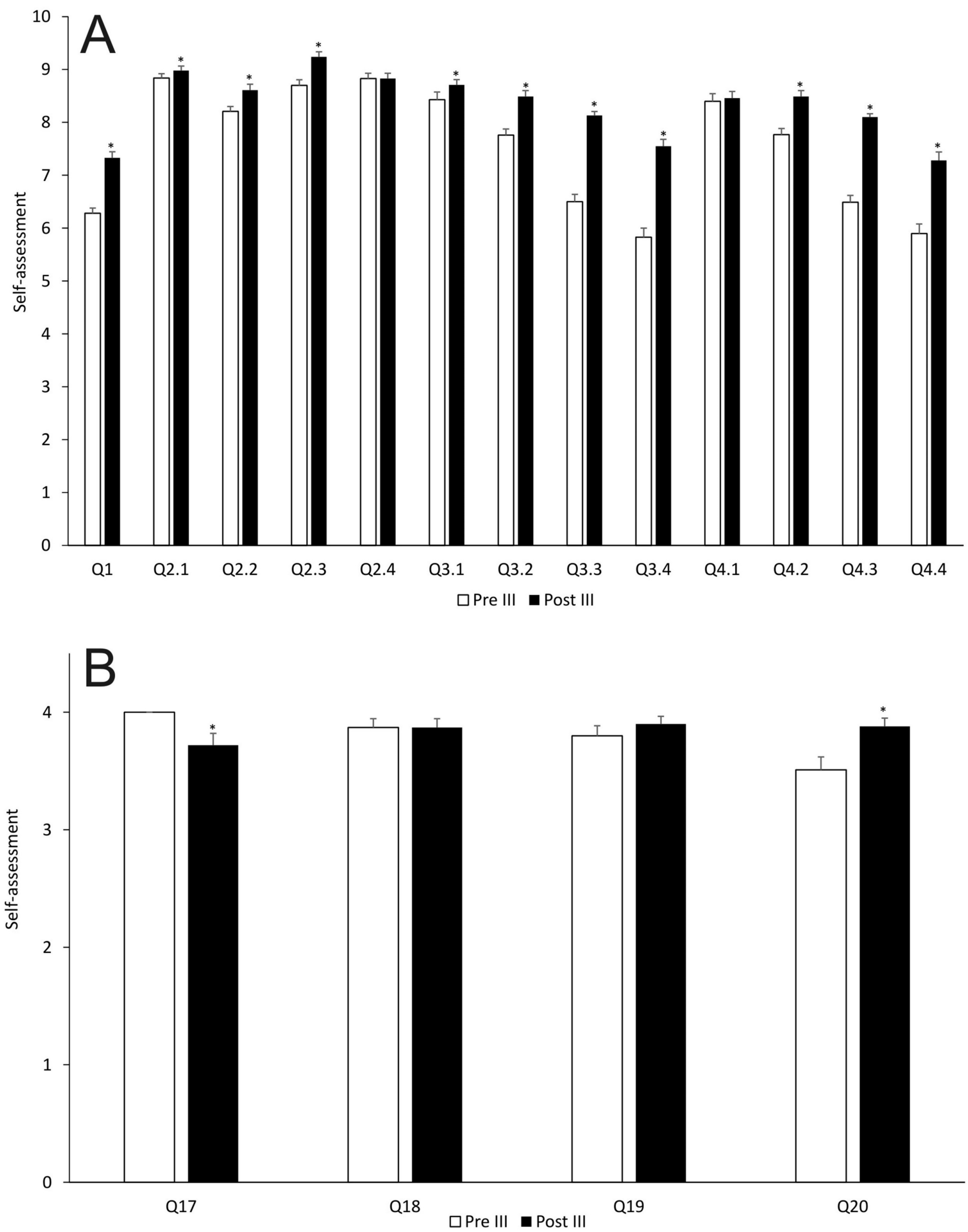


Figure 5. 3 – Evolution over time comparing pre-course and post-course - year III. Panel A: Questions Q1 – Q4.4. Panel B: Questions Q17-Q20. Mean ± 95% CI. *p<0.05

During the simulation training in the fourth year, similar to what happened in the third one, there were no differences in the importance of neuromuscular block monitoring (Figure 5.4, Panel A, Q2.4). In all the questions of Panel B (Figure 5.4), the residents strongly agreed even before the simulation course started.

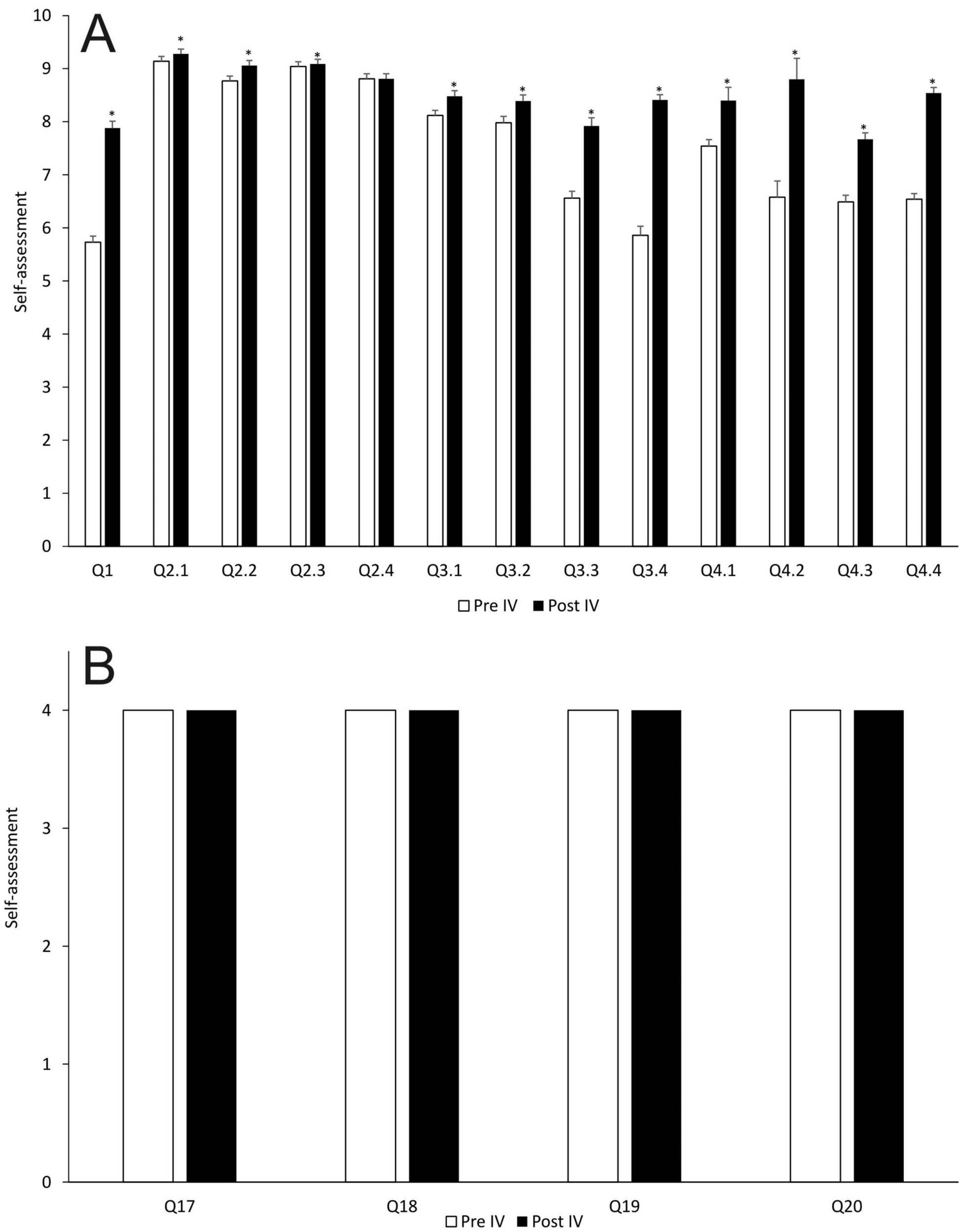


Figure 5. 4 – Evolution over time comparing pre-course and post-course - year IV. Panel A: Questions Q1 – Q4.4. Panel B: Questions Q17-Q20. Mean ± 95% CI. *p<0.05

Regarding the four questions that only belong to the year III questionnaire, respecting obstetric emergencies (Q3.5 and Q3.6) and trauma (Q4.5 and Q4.6), the progression of the self-assessment was positive in all the questions ($p<0.05$). Question 3.5: pre 6.44 (6.31-6.56) and post 8.10 (8.03-8.16); question 3.6: pre 6.83 (6.70-6.96) and post 8.84 (8.76-8.92); question 4.5: pre 6.43 (6.30-6.55) and post 8.06 (7.98-8.14); question 4.6: pre 6.86 (6.70-6.86), post 8.85 (8.77-8.92).

5.3.2 Post-simulation course compared with the pre-simulation course of the following year

Figures 5.5, 5.6, and 5.7 correspond to the post-simulation course compared with the pre simulation course of the following year: post year I versus pre-year II, post year II versus pre-year III, and post year III versus pre-year IV, respectively.

Between course comparisons, there were no differences in Q3.3 regarding the training for emergencies in clinical practice (Figure 5.5 panel A) and Q20 about the impact on patients´ clinical outcomes (Figure 5.5, Panel B). Between post year II and pre year III, there were also no differences in airway management's importance (Figure 5.6, Panel A, Q2.1) and ventilatory monitoring (Figure 5.6, Panel A, Q2.2). There were also no differences in their expertise in difficult airway management (Figure 6, Panel A, Q4.1) and ALS (Figure 5.6, Panel A, Q4.2). In Figure 5.7, Panel B, there were no differences in any of the questions except Q17. In the last comparison between years, all the answers were significantly different except for the residents' opinions in ventilatory monitoring (Figure 5.7, Panel A, Q2.2) and neuromuscular block monitoring (Figure 5.7, Panel A, Q2.2).

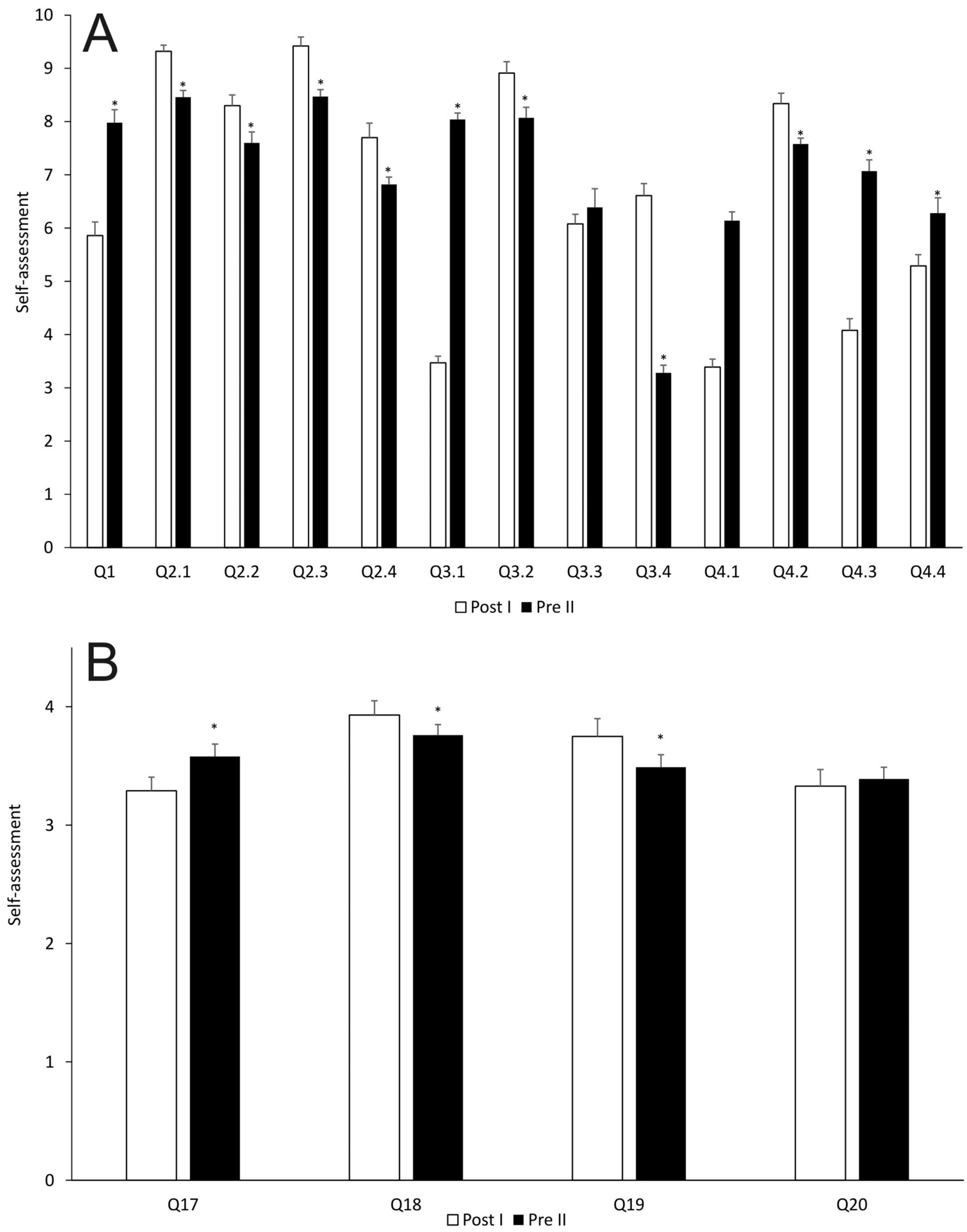


Figure 5. 5 – Evolution over time comparing post-course year I and pre-course year II. Panel A: Questions Q1 – Q4.4. Panel B: Questions Q17-Q20. Mean ± 95% CI. *p<0.05

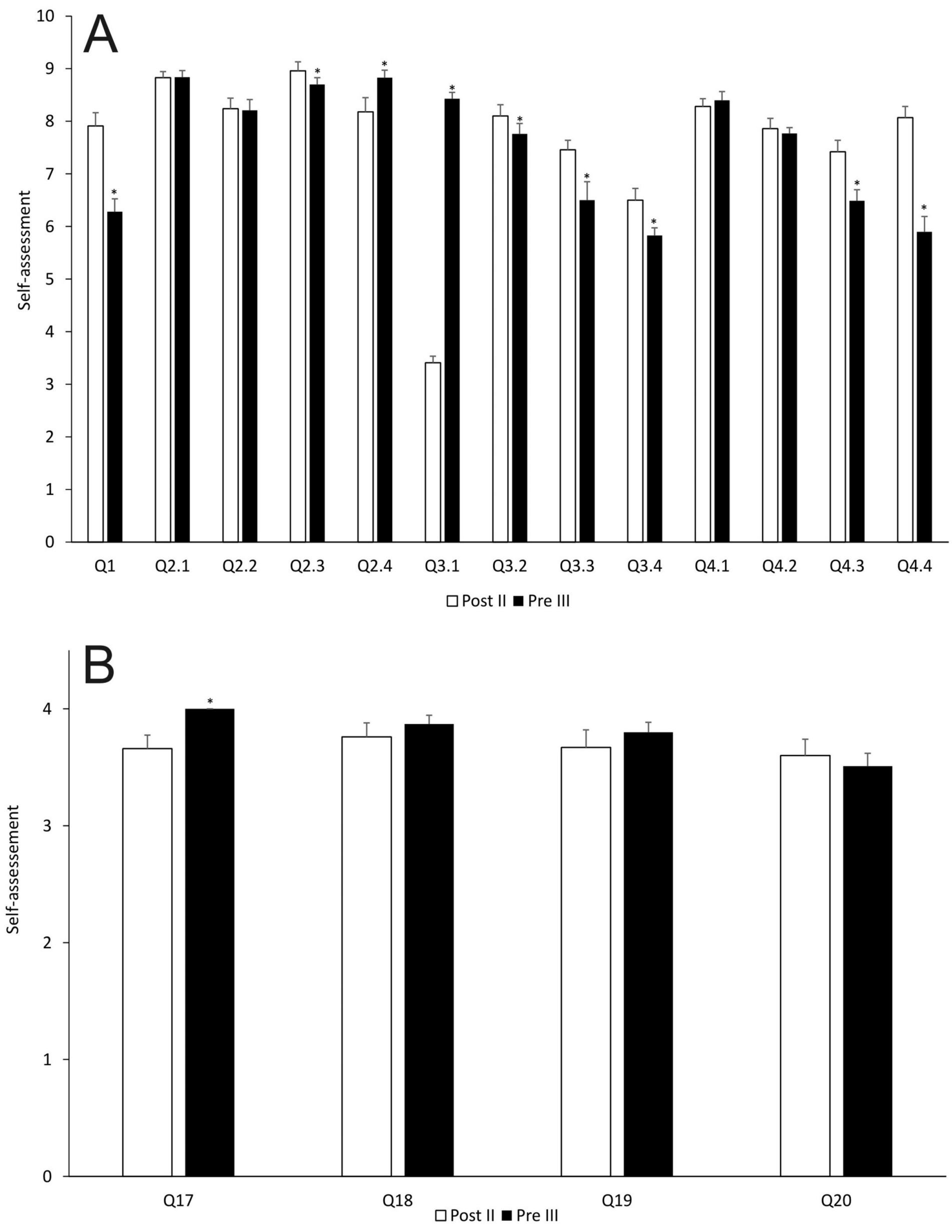


Figure 5. 6 – Evolution over time comparing post-course year II and pre-course year III. Panel A: Questions Q1 – Q4.4. Panel B: Questions Q17-Q20. Mean ± 95% CI. *p<0.05

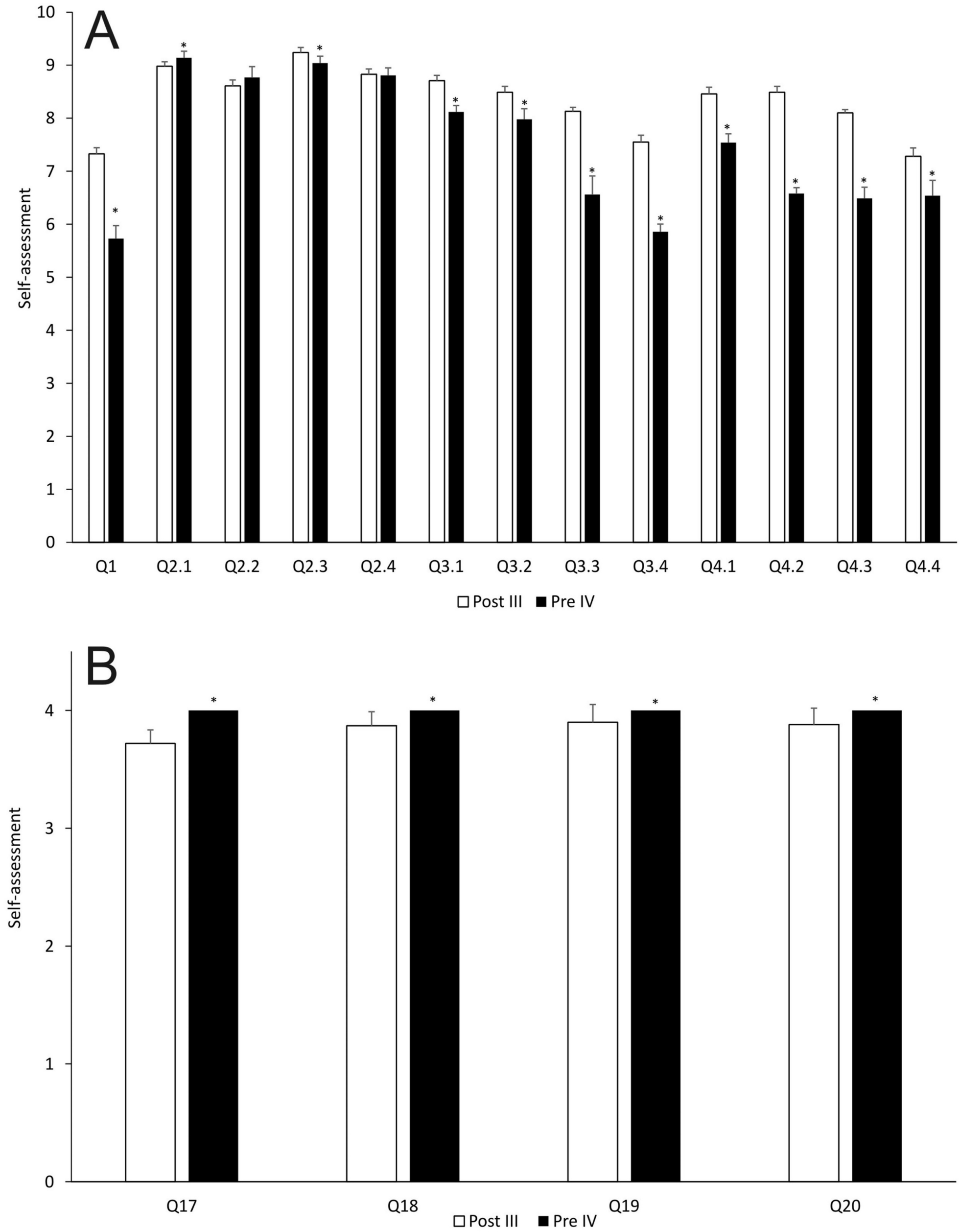


Figure 5. 7 – Evolution over time comparing post-course year III and pre-course year IV. Panel A: Questions Q1 – Q4.4. Panel B: Questions Q17-Q20. Mean ± 95% CI. *p<0.05

5.3.3 Pre-simulation course in year I compared with the post-simulation course at year IV

Figure 5.8 represents a global comparison between pre-year I and post-year IV.

All evolutions were self-assessed as positive except for question 3.3 regarding the importance of cardiac monitoring that was already high before the first-year simulation course and therefore, the difference for the post-fourth year evaluation was not significantly different.

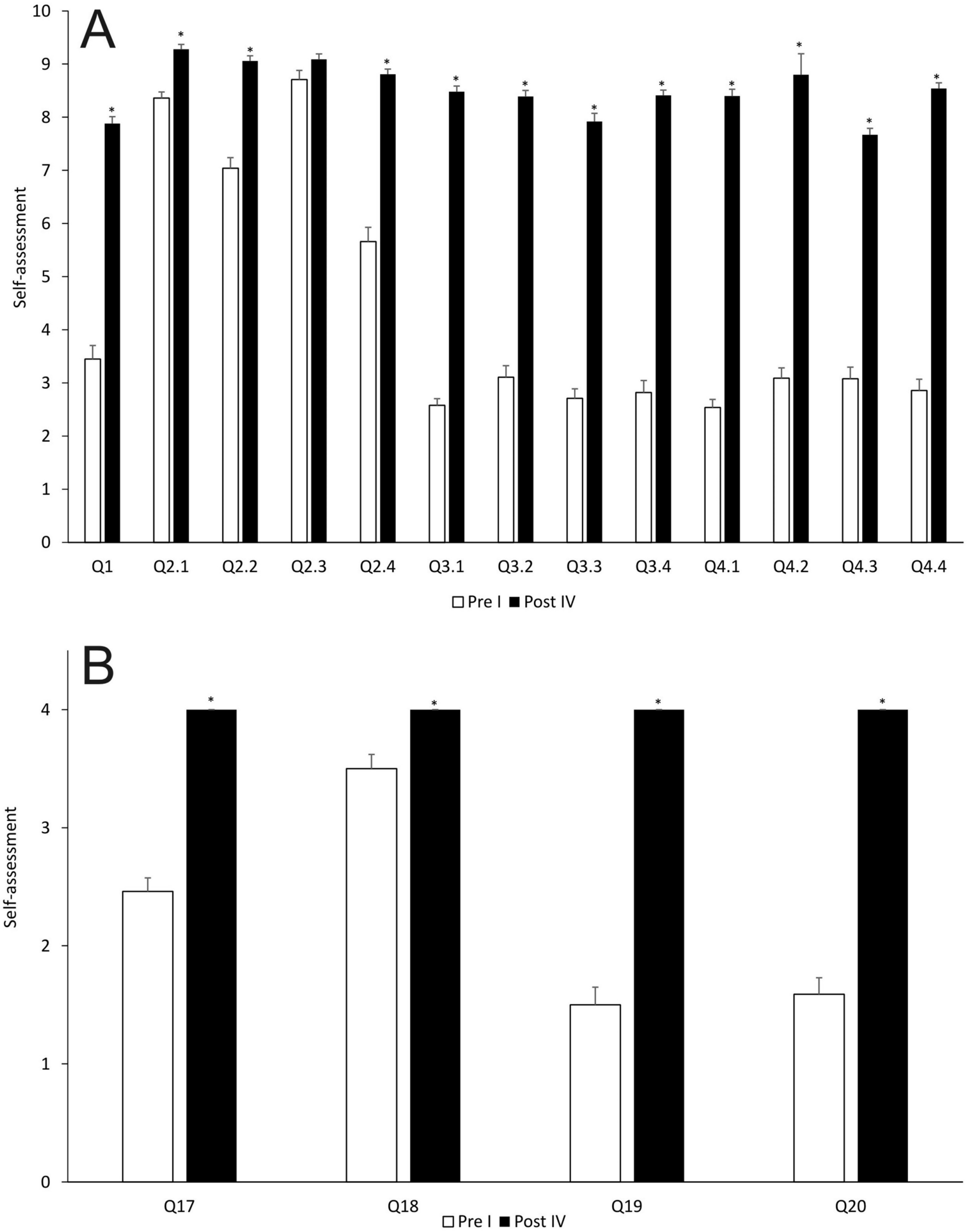


Figure 5. 8 – Global evolution of the simulation courses pre-course year I and post-course year IV.

5.4 Discussion

Our study demonstrates that during every simulation course of each specific year of Anesthesiology residency, the self-assessment of learning and competencies developed increased. Moreover, in the first year, the value of the self-assessment in the pre-and post-course evaluation on the simulation's role was several folds different. In the remaining years, the differences were not so pronounced (Part I). Respecting the self-assessment learning results between simulation courses, there was an overall drop from post-simulation assessment in the previous year compared with the pre-simulation assessment of the following year (Part II). Finally, self-assessment of the simulation courses was positive for all the evaluated parameters, meaning that the self-perception of competence improved the key for any educational program (Part III). The unique exception is for the self-assessment of the importance of cardiac monitoring that was as high at the beginning of the simulation courses as it was at the end. However, we have to point out that it is not entirely attributable to simulation since the evaluation was done by residents in a constant learning process, according to each year's pedagogical content.

In Portugal, undergraduate medical education did not include Anesthesiology. Therefore, residents' first contact with this medical specialty and its different components are during their post-graduate training. It is the justification for the evidence found in our results that the simulation had a major role in the first year compared with the following years.

The fluctuations in the knowledge process, namely between the different courses, demonstrated that they moved on a Dreyfuss' knowledge acquisition curve from unconsciously incompetent to consciously incompetent.[112] This is also related to the experience and awareness of Anesthesiology residents' performance during the specific residence year. Moreover, there may also be some loss of concepts throughout the year that influences their self-evaluation.

During the first-year course, residents increased their confidence regarding technical skills such as airway management, ventilatory, cardiac, and neuromuscular block and their importance in Anesthesiology. Although there was a slight decrease between post-course I and pre-course II, the values stabilized after post-course II until the end of the study. Nevertheless, besides this knowledge, the knowledge/awareness process fluctuations were much more marked, except ALS, which stabilized after pre-course II. ALS belongs to the first-year curriculum, and therefore these results suggest that the training in the first year was sufficient for the residents' knowledge in this crucial area. Moreover, the variations in the experience in ALS presented the same pattern. The impact of simulation training in advanced life support is documented: in combination with traditional medical training, it showed promising results compared with traditional education.[113]

The changes in the training in difficult airway management seemed to be a paradox since, after a marked increase between post-course I and pre-course II, there was a steep decrease during simulation course II. The marked increase suggests that residents had significant contact with airway management during the first residency year and perceived that they had a high level of training in this skill. However, during the simulation course of year II, and when specific training in the management of difficult airway was taught, they gained awareness that, after all, there was a critical gap in their training regarding this skill. Notwithstanding, the experience regarding difficult airway management stabilized after post-course II until the end of the program with a slight decrease between post-course III and pre-course IV, again demonstrating the gain of awareness at different time points of the training process and a loss of concepts throughout the year.

It is of paramount importance since airway management is a cornerstone in Anesthesiology, Emergency, and Critical Care Medicine that can have a huge impact on patient safety.[16,52,114,115] The level of training is crucial for the success of airway management, reducing pulmonary aspiration, and consequently improving patient safety.[106]

Emergencies and critical events management simulation belong to last year course, which may explain the fluctuations found not only in training but also in the experience. Every simulation course (pre-post comparison) had a positive role in training and experience in emergencies and critical events management. Nevertheless, in the time between simulation courses (post-pre comparison), the average self-assessment decreased. It suggests that during residency, residents gain conscientiousness regarding their training and the gaps it carries.

This was also demonstrated regarding their preparation for critical events: until post-course year II, residents perceived an increase and stabilization (pre-II-post-II) on their preparation in critical events management. However, after that, fluctuations occur, and although the preparation increased during the simulation course, it decreased between consecutive simulation courses. It is known that clinicians' performance during a crisis is variable and imperfect. Simulation seems to be well suited to fill this potentially lethal gap without an impact on patient safety.[116,117]

It was somewhat unexpected to find that the positive effect of simulation in team training was relatively low initially, increased after post year I, and stabilized. The same pattern was verified in the importance attributed to team simulation training in patients' clinical evolution. Team training is critical in Anesthesia since the team is composed of elements with different degrees of training, experience, and skills, that work in a technologically complex environment and, often, without previous mutual knowledge.[114] Moreover, Anesthesiology is the medical field that is more frequently exposed to critical events in an Emergency, Operating Room, and Intensive Care, which strengthens the need for team working.[118]

During residency, trainees are shaped into independent clinicians, and simulation increases the learning opportunities, sharing responsibility for patient safety, and overcoming communication barriers.[119] With an education based on simulation, residents, can acquire psychomotor skills required for a procedure and become "pre-trained novices" in their first standardized procedures with real patients.[17] However, it is still unclear how simulation should be effectively incorporated in education. One crucial issue is the standardization of all aspects of simulation healthcare, such as the curriculum, the staff, the environment, and the methods of teaching, research, or assessment.[120] The impact or benefit of simulation-based training should be rigorously assessed by research in its various dimensions.[96,121-123] One of the dimensions is the resident self-assessment that was performed in this study.

This study was a national, innovative, and comprehensive project in which enrolment was optional, and we had to find a balance that would allow us to evaluate the program itself. We considered that a more formal assessment could inhibit participants from enrolling, compromising the program itself. Nevertheless, our results are only based on residents' self-evaluation, which is a limitation since it only addressed the simulation training results in the residency context, from the resident point of view. Therefore, the results may be skewed by different self-perceptions, and there was no independent evaluation of the learning curve to confirm this self-evaluation. Therefore, further studies need to objectively address the residents' performance, evaluated by the trainer. Finally, since only residents who voluntarily enrolled in the program were included, they are a priori, more prone, and willing to learn.

5.5 Conclusion

This study shows that a simulation program standardized according to the Portuguese Board of Anesthesiology's curricular objectives positively impacts the learning process of Anesthesiology residents. Our results also give some clues for the impact of simulation in medical education outside the Anesthesiology area: a structured simulation program based on each residency field's learning objectives would positively impact the training and the behavior of the residents.

In the first year of the residency, the simulation's role was more noticeable than in the following years. Between simulation courses, there was a decrease in the self-assessment of the learning process, which could be attributable to the gain of conscience. Taken together, our results showed that the creation of a National Project aimed to be available for all the residents in Anesthesiology will be successful in the improvement of their clinical performance, complementing traditional education and allowing to follow-up the participants during the four years of the residency.

Chapter 6: Evaluation of the National Pedagogical Plan for Anesthesiology residents: the participants´ rating

This chapter is submitted as an original paper Matos F. M., Martins M. R., Martins I., Fernandes N. Evaluation of the National Pedagogical Plan for Anesthesiology residents: the participants´ rating, *submitted*.

6.1 Introduction

To build a simulation program, the needs and goals of the participants should be defined and the learning objectives.[8,52]

In Anesthesiology, the team comprises elements with different levels of training, experience, and skills that work together in an environment with high technological complexity.[8,52] Simulation appears as the tool able to suppress the lacunae in traditional education, available for all the residents in Anesthesiology.[96] These facts, together with a difficult learning curve of the different procedures and a potentially high risk for the patients, lead to the development of a complementary education tool, oriented by the pedagogical goals defined by the Portuguese Specialty College.[53,96]

The implementation of the Portuguese National Pedagogical Plan at the BSC-CHUC, Portugal, had four main goals: to facilitate the acquisition of theoretical knowledge, to allow the acquisition of technical competencies, to allow the practice of critical situations, and to facilitate the team training, communication, and leadership. During this simulation course, the performance of the residents was self-evaluated in its two main components: technical and non-technical skills.[92,111] Besides this self-evaluation of the competencies acquired during the simulation course, and since the National Pedagogical Plan should be implemented as a complement of the residency in Anesthesiology, the program contents should suppress the lacunae that residents faced during their clinical practice. It is fundamental to analyze the importance and, consequently, each topic's satisfaction in the simulation course.

This study aimed to evaluate the importance attributed by the participants to each topic of the National Pedagogical Plan which revealed the satisfaction regarding the simulation courses to suppress the needs faced, by the residents, in the clinical practice.

6.2 Methods

6.2.1 Study design

This prospective observational study was designed to evaluate the impact of the Anesthesiology Simulation Pedagogical Plan from BSC-CHUC in the self-assessment of confidence, behavior, and training of the Portuguese Anesthesiology residents. Each simulation module was designed according to the program contents of each year of the ARP, and the scripts/scenarios were previously published.[53,92] Questionnaires included questions about learning, behavior, and evaluation of each simulation course's pedagogical content. This paper presents the results of the importance, attributed by the participants, of the pedagogical content of each simulation course performed after the simulation course (Table 6.1). The complete questionnaires included were published previously.[111]

Table 6. 1 – Questionnaires applied in each module for each specific year of ARP. These questions were performed post-simulation courses to evaluate each topic's importance in a simulation context

Year I	
21	Basic Pharmacology in Anesthesiology: topic importance
22	Basic and advanced airway: topic importance
23	Ventilation: topic importance
24.	Vascular cannulation in anesthesia: topic importance
25.	Ultrasound in anesthesia: topic importance
26.	Central and peripheral cannulation using ultrasound: topic importance
27.	Neuraxial anesthesia and local anesthetics: topic importance
28	Simulation training on Operation Room - clinical cases
28.1	Topic importance
28.2	Training impact
29	Simulation training on post-anesthesia care unit – clinical cases
29.1	Topic importance
29.2	Formative impact
30	Etiology and prevention of cardiorespiratory arrest: topic importance
31	BLS algorithm: topic importance
32	ALS algorithm: topic importance

33	Recognition of rhythms: topic importance
34	Defibrillation: topic importance: topic importance
35	Simulation training on ALS – clinical cases
35.1	Topic relevance
35.2	Formative impact
36	Global evaluation
Year II	
37	Leadership and health management: topic importance
38	Difficult Airway Algorithm: topic importance
39	Supraglottic and transcutaneous devices: topic importance
40	Fibroscopy principles: topic importance
41	Simulation training on difficult airway – clinical cases
41.1	Topic relevance
41.2	Formative impact
42	Ultrasound in Anesthesiology: topic importance
43	Ultrasound-guided regional blocks: topic importance
44	Simulation training on ultrasound-guided regional blocks – clinical cases
44.1	Topic relevance
44.2	Formative impact
45	The anesthetic approach of the burnt patient
46	Simulation training on the anesthetic approach to the burned patient – clinical cases
46.1	Topic relevance
46.2	Formative impact
47	Global evaluation
Year III	
48	Assessment of a trauma patient, head and thoracic trauma: topic importance
49	Abdominal trauma: topic importance
50	Massive hemorrhage management: topic importance
51	Trauma in the pregnant: topic importance
52	Simulation training on trauma – clinical cases
52.1	Topic importance
52.3	Formative impact

53	Pathophysiology and management of ARDS topic importance
54	ARDS ventilation: topic importance
55	Pathophysiology of sepsis: topic importance
56	Management of a septic patient: topic importance
57	Simulation training on Intensive Care – clinical cases
57.1	Topic importance
57.2	Formative impact
58	Anatomy-physiological changes of pregnancy
59	Labour analgesia
60	Obstetric emergencies: topic importance
61	Simulation training on obstetric Anesthesiology – clinical cases
61.1	Topic importance
61.2	Formative impact
62	Global evaluation
Year IV	
63	Effective communication: topic importance
64	ACRM: topic importance
65	ACRM principle
66	Simulation training on ACRM – clinical cases
66.1	Topic importance
66.2	Formative impact
67	Emergencies in the OR
68	Simulation training OR emergencies – clinical cases
68.1	Topic importance
68.2	Formative impact
69	Global evolution

ARP - Anesthesiology Residency Program; BLS - Basic Life Support ALS - Advanced Life Support; ARDS - Acute Respiratory Distress Syndrome; ACRM - Anesthesiology Crisis Resource Management.

6.2.2 Questionnaires development and validation

The process of development and validation of questionnaires were previously described and published.[111]

6.2.3 Setting and participants

This study was an observational study conducted in Portugal, from 2011 to 2018, at BSC-CHUC. The same simulation courses of BSC-CHUC were offered since February 2011. The simulation environment included three simulation rooms: an OR, a Recovery Room, and an Emergency Room. Four participants were included in each section with the roles of senior fellow (1st help), fellow, and two residents. The residents were active in hot seats. The script of the scenarios[92] is related to the content of each module, described in Table 6.1. Annually, approximately 15 residents of each year participate in the course. Simulation courses were performed during the first trimester of each specific year.

Participants were Anesthesiology residents enrolled in the simulation courses at BSC-CHUC.
Inclusion criteria: All Anesthesiology residents enrolled in the Anesthesiology simulation courses at BSC-CHUC. Exclusion criteria did not exist.

Ethical approval for this study (Ethical Committee Nº 171/ CES) was provided, retrospectively, by the Ethical Committee from CHUC, Coimbra, Portugal (Chairperson Prof. Doutor João Pedroso de Lima) on 18 July 2019. Written informed consent has been waived by the Ethical Committee (Attachment II).

6.2.4 Variables and method of assessment

All variables were collected on an anonymized database specifically designed for the study. The source of all the variables was the specific questionnaires applied after each simulation course. Answers were given on an eleven-point Likert Scale (0-10, ranging from null to maximum).

6.2.5 Bias

The study was only based on students' self-assessment, which can constitute a source of bias due to intra-personal variability.

6.2.6 Quantitative variables

All collected variables were quantitative.

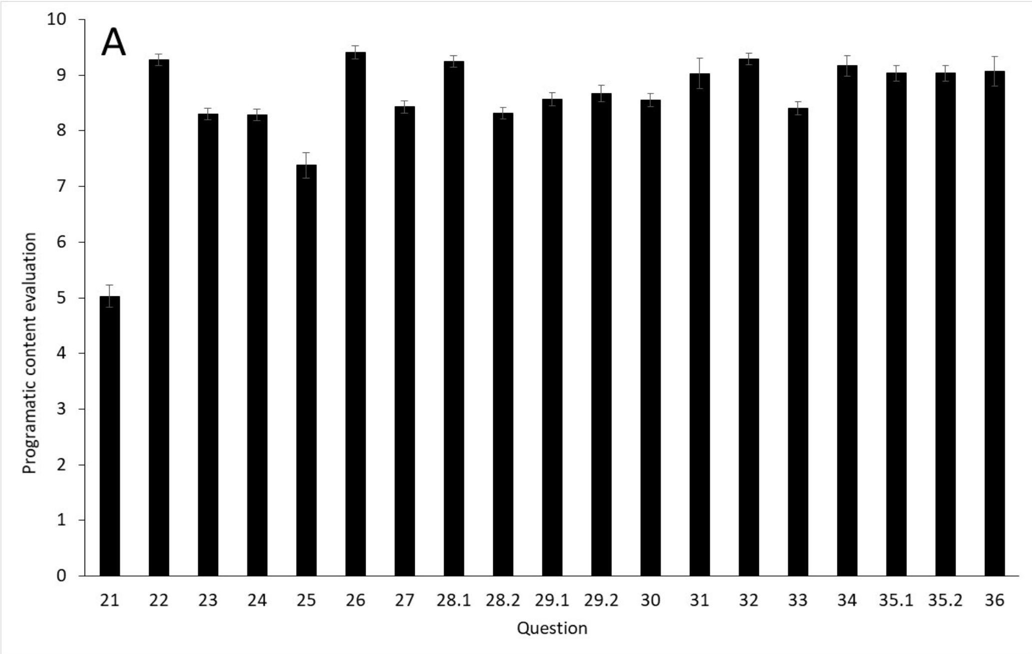
6.2.7 Statistical methods

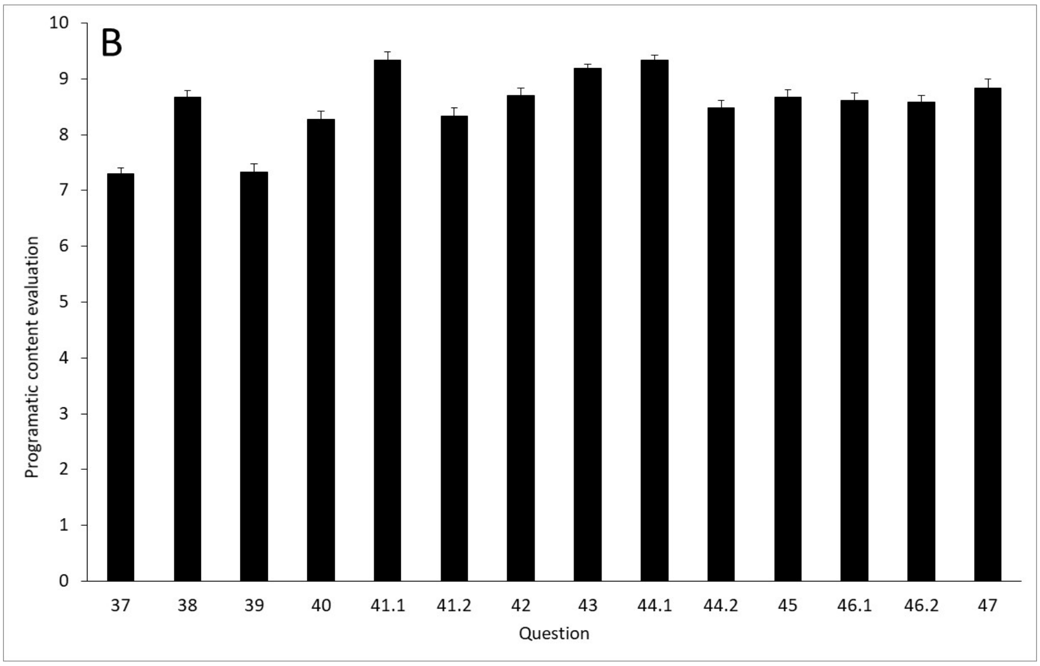
Descriptive statistics were used. Results were presented as mean (95% CI).

6.3 Results

Three-hundred and forty validated questionnaires were included in the study: 76 from the year I, 89 from the year II, 82 from the year III, and 93 from the year IV. The mean age of the residents in the first year was 26.5 years of age with a minimum of 25 years and a maximum of 29 years.

The mean of the resident assessment for each question of Table 1, regarding programmatic content importance, is represented in Figure 6.1. Figure 6.1 is grouped in four panels corresponding to each year of the simulation module: Panel A - the year I; Panel B - year II; Panel C - year III and Panel D - year IV.


A
Programatic content evaluation
Question
21 22 23 24 25 26 27 28.1 28.2 29.1 29.2 30 31 32 33 34 35.1 35.2 36


B
Programatic content evaluation
Question
37 38 39 40 41.1 41.2 42 43 44.1 44.2 45 46.1 46.2 47

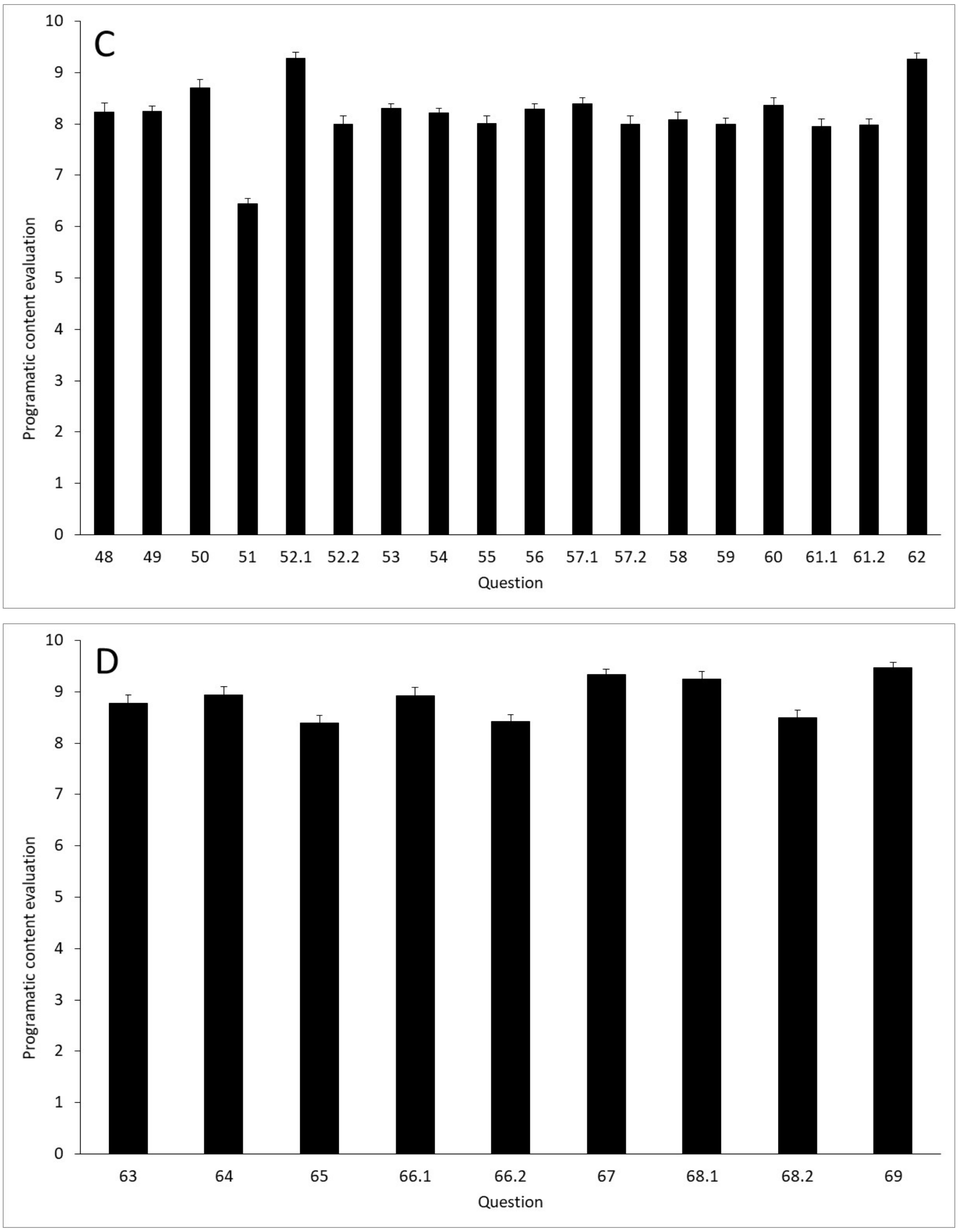


Figure 6. 1 – Residents' evaluation of each topic's importance addressed in the simulation course. Results are presented in mean (CI 95%). A - year I. B - year II. C - year III. D - year IV.

6.4 Discussion

The perceptions about the role of simulation in Anesthesiology training are well documented. Simulation has a positive effect on the students' technical and non-technical skills, namely in Anesthesiology residents.[8,16,52,92,101,111] In this study, we evaluate the impact of a 4-year simulation course designed specifically on curricular goals defined for the Portuguese Anesthesiology Residency Program. For that, the simulation modules were proposed to be performed in the first trimester of each year. It is the unique way to accomplish the main objective of simulation: to learn in a safe environment, without risk for the patient[16], once the first approach to each specific competency occurs in a controlled simulation setting. Since the simulation-based training is resource-intensive and there is a need to prioritize the contents and adapt the courses to the main needs and lacunae of the participants[8,52], it is crucial to understand the students' perception of the contents included in the simulation training.

In this paper, we presented the students' evaluation of the importance of each topic included in each simulation module. Thus, the questions were only answered after participation in the simulation course.

From the analysis of Figure 6.1 we can conclude that it is essential for the students to practice each of the programmatic content in a simulation context, including the clinical cases in which, beyond the topic importance, the students evaluated the formative impact. The year I was the one in which more programmatic contents were addressed and consequently had a higher number of questions. Basic pharmacology in Anesthesiology is the topic to which was given less importance: with a mean of approximately five and a low dispersion, showing a high concordance between the students. Interestingly, this topic was not included in the final prioritized list of 30 procedures groups for simulation in Anesthesiology, recently developed by a Consensus Panel.[52] Nevertheless, the study of pharmacology in Anesthesiology has been associated with more effective learning and long-lasting retention compared to lectures alone.[124] The global evaluation of the course of the first year is very high.

In year II, different topics were approached. In general, the evaluation was very positive, and only questions 37 and 39 had a numerically low evaluation, approximately 7. Question 37 can be interpreted as a behavior question: leadership and health management are non-technical skills. Leadership and health-management focus on interprofessional team training in healthcare education, together with communication and situation awareness.[8] For good leadership and management, participants, should interact with each other, with the environment, and with the manikin ("patient").[8] The evaluation performed by the students could reveal some immaturity since they are at the beginning of their second year and they are concerned with technical skills. Nevertheless, it is proven that simulation-based training has the advantage of improving self-confidence, situation awareness, communication, and leadership.[98,111]

Question 39 is related to supraglottic and transcutaneous devices. These devices are an essential second-line tool during difficult airway management after a failed tracheal intubation and require sufficient training. Moreover, they are related to a procedure included in the recommended final list of 30 prioritized procedures for the simulation-based training in Anesthesiology.[52] However, and besides the indications for using these devices and their prominent role in managing the difficult airway, they are not widely used.[115] Moreover, a recent study showed that the feasibility of simulation for this training depends on the type of manikin.[125] The previous knowledge about the scarce use of these devices and a more appropriate manikin could impact the importance given to this theme by the students.

As in year I and year II, the students' general evaluation of year III was excellent. Trauma in pregnancy was the unique issue with a mean of less than 7, approximately 6.5. It is estimated that trauma complicates approximately seven in 12 pregnancies being vehicle crashes and falls due to instability, the predominant cause of reported trauma during pregnancy. The management of trauma in pregnant women should be done to minimize maternal injury, leading to maternal stabilization.[126] However, in this situation, the medical doctors must deal with a higher stress situation, and for this management, the simulation could be of extreme importance. The residents' lower importance relates to the fact that initially, a traumatically injured pregnant woman should be treated as their nongravid counterparts. Therefore, the general management of trauma is more critical in simulation courses than the management of trauma in pregnancy.

Year IV is the last year of the residency. In the simulation modules of this year, ACRM, including communication and emergencies in the OR, are the main explored concepts. All the questions were evaluated by the students with a high score (more than 8), meaning that in the last year of their residency, they found crucial the learning process based on simulation when exposed to the more challenging situations.

Some limitations of this study have been noted. Methodologically, and for a more concise analysis of the simulation courses' impact on the residents´ learning process, a pre-course questionnaire should be applied to the students. Only with these pre and post results would we analyze how the importance attributed to each programmatic content change due to the simulation course. To overcome this, in future simulation courses, questionnaires should be applied before and after the courses.

6.5 Conclusion

This study showed that from the perspective of the residents in Anesthesiology, most of the topics included in the simulation modules are of utmost importance and should be included in the simulation courses.

Chapter 7: Global discussion and conclusion

7.1 Global discussion

It is believed that the improvement of patient care is sustained by the increase in the skill and ability of healthcare professionals.[127] The path that a medical student has to go through to become a specialist is long, and the acquisition of competencies is crucial. According to the Canadian Medical Education Directives for Specialists (CanMEDs Roles) and the Accreditation Council for Graduate Medical Education (ACGME), competencies are defined as the abilities needed for practice. As part of these competencies, these two entities include medical expertise, communication, collaboration, health advocacy, patient care, practice-based learning and improvement, and professionalism.[127]

Anesthesiology is a medical specialty where all these competencies should be learned and acquired, since technical skills and non-technical skills such as communication and leadership are crucial for efficient patient care. During this constructive process, it is essential to understand how people learn and therefore provide training that is well planned and based on pedagogical research. For an educational study's success, some issues should be addressed, such as the formulation of the research question that will determine the study methodology and how to assess the data.[46]

In order for this to be achieved, quantitative assessments should be used in medical education research, similar to the approach used in clinical research: a structured process involving careful protocol development based on a straightforward question, subject recruitment, data analysis, reporting, and dissemination of the results. Consequently, there has been a continued increase in medical educational research publications.[46,128,129] Although there are multiple forms of quantitative assessment, these should be reliable, reproducible, suitable, valid, and present internal consistency.[128,129] Specifically, in Anesthesiology and non-technical skills, the more challenging skills to evaluate quantitatively, few instruments have been developed and validated.[129-131] The assessment instrument Anesthesiologists' Non-Technical Skills has been adapted in different versions and showed good validity evidence regardless of content, response process, and internal structure for ratings.[131,132] Nevertheless, none of these instruments is commonly accepted nor are they validated among Anesthesiology specialists dedicated to medical education.

This work was divided into two main parts aiming to increase the efficacy and safety of Anesthesiology training during residency. The first part figures out how a mixed-realism simulation repercuss communication skills. After participating in the mixed-realism scenario, residents' communication skills were assessed with a toll explicitly designed for that. In the second part, participants on the biomedical simulation courses attended during the Anesthesiology residency self-assessed technical and non-technical competencies.

In the first part of this study, Chapter 3, we developed a reliable two-part instrument that can be used to assess disclosure performance. This non-technical skill would contribute to a better patient-clinician confidence relationship, decreasing the stress associated with the communication of bad news.[133] This disclosure is related to a medical error that originated in a non-proper professional and ethical behavior leading to a breach of trust in the doctor-patient relationship.[134] Once the residents know that they are being trained and evaluated, they tend to reduce explicit and implicit occultation associated with improper behavior.[135] The training of these abilities in a simulation context contributes to reducing patient injury by accelerating the different stages of the grief process, from denial to acceptance. This result has also been demonstrated in another study tool in which the training linked to medical errors increased awareness and proactive handling of the errors.[136]

Moreover, the methodology used is a comprehensive one, mixing realism with simulation, allowing for the practice of adverse events disclosure – belonging to advanced communication skills that all trainees in Anesthesiology should acquire during their residency in Anesthesiology and preferentially before the direct contact with a patient. In this difficult conversation with the patient, our structured technique contributes to the physician´s willingness and ability to engage in this challenging task. Another study using an immersive experience with a high fidelity simulation and SPs demonstrated that communication concerning a critical incident, namely conveying bad news, in Anesthesiology residents could be improved with educational intervention based on simulation.[137] The assessment of the acquisition was performed with GRIEV_ING instruments that were proven adequate for this goal.[137,138]

Taken together, this part of the work supports the inclusion of training in adverse events disclosure in residents' curricula in Anesthesiology. Nevertheless, adverse events disclosure and conveying bad news are not exclusive of the Anesthesiology field, and simulation is a useful resource in different medical education areas.[139-145]

Moreover, this first part of our study impulses the design and development of Portuguese Simulation training for residents in Anesthesiology, based on scripts and protocols that grant the training of technical and non-technical skills, such as team patient-clinician communication.

In 2011, the Biomedical Simulation Centre from Centro Hospitalar Universitário de Coimbra (CSB-CHUC), Portugal, implemented four simulation modules designed specifically for the residents in Anesthesiology, according to recommendations from the Portuguese College of Anesthesiology, for each specific year of residency. With the implementation of these courses as part of the learning process, there was a need to evaluate how these courses impacted the learning of different competencies, both technical and non-technical. To this end, another evaluating tool was developed and validated: a questionnaire for Anesthesiology trainees' self-assessment before and after the simulation modules. Self-assessment can be one of the components of evaluating the learning process and has been widely used in this context.[91,146,147]

In this study, the research question was: *How does simulation training in Anesthesiology residents impact their learning and acquisition of competencies?* According to Kirkpatrick's framework[46], we evaluated the impact at level 1: reaction and level 2: learning. The educational intervention was only studied by measuring specific outcomes in a laboratory setting, in this case, a simulation room. Therefore, it pertains to level T1 of translational research.[148]

To answer our research question, a quantitative approach, based on questionnaires, was designed. The most challenging part of this methodology was to devise a valid questionnaire that allows access to all the data needed for its correct interpretation and sustainable publication.[46] Questionnaires were applied before and after the courses to detect the changes resulting from the learning activity. Data were assessed directly from the participants and collected on an anonymized database.

Since the questionnaires were equal for the four years, we will discuss the results based on a *before-after* approach of each module. In a complementary way, we will discuss the results *after the module-before next year's module*. This will allow us to understand how the training in the clinical setting impacts the learning and confidence of the students and if the change, due to the simulation course, is sustained over time.[46] These are the results presented in Chapters four and five.[111]

Additionally, besides the main core questionnaires that were equal for evaluating the four simulation modules, there was a list of questions that were only applied before each course (module). These final questions were related to each course's specific content and intended to ascertain the importance given by the students to the simulation approach of each content (Chapter 6).

The analysis of each year's results showed that the simulation courses positively impacted the students' learning process since most of the answers significantly increased their value immediately after the simulation course. Nevertheless, there were some exceptions.

In the **first year**, only four questions did not change their results with the simulation courses: Q5, Q7, Q9, and Q11. These questions are not related to the specific contents of the first year of the Portuguese Anesthesiology residency. Question Q5 and Q7 are associated with the need for support and are essential to highlight that these students were in their first year of residency and therefore were not exposed to critical situations alone. It is the reason why most of them did not feel the need for help. Q9 is a communication question; before and after the course, students partially assumed difficulties communicating their mistakes. At this stage, we were not expecting that simulation courses changed these issues. Regarding question Q11, it was interesting to note the students' ability to understand their limitations in the first year: most students did not have enough knowledge.

In the **second year**, simulation training did not change the students' self-assessment concerning their preparation for critical events in the OR. Emergencies in the OR are only included in the fourth-year module. Since this pedagogic content was not trained in the simulation room, it was an expected result. However, an unexpected result was question Q3.2: training in advanced life support, that is a pedagogic content of the first module, and therefore we were expecting a different self-assessment before and after the participation in the simulation module. Nevertheless, the self-assessment was high (approximately 8). As in the first year, self-assessment of mistakes communication (Q9) did not change with the simulation course, notwithstanding that, in this year, students assumed to have fewer difficulties in the communication of their own mistakes. The self-evaluation of general training (Q12) was also not affected by the simulation, and the opinion about the shame of calling for help from senior fellows (Q14 and Q15) did not change with the simulation course. The last point regarding this second year was about the periodic update plan using simulation (Q18). Although most residents assumed to agree partially with this, the simulation course did not change their opinion.

In summary, many questions in which we cannot see an impact of the simulation course were more associated with behavior, except for training in advanced life support. In these first years of residency, students are more prone to technical skills and consequently did not give so much importance to non-technical skills.

In the **third year,** simulation courses impacted all the questions about "importance" (Q2), except for the monitoring of neuromuscular blocking (Q2.4). This was an expected result since neuromuscular blocking belongs to the first-year pedagogical content, and the importance attributed by the residents was high, approximately 9. Regarding their own experience (Q4), simulation changed the values attributed to all the points except for difficult airway (Q4.1) that was part of the first module content. However, it is essential to note that students assumed a high experience level in this content, approximately 8.5. The different situations of emergency included in this module justify the impact of simulation in the experience of advanced life support (Q4.2), emergencies (Q4.3), and management of critical events (Q4.4). In awareness questions, the simulation did not impact Q5, Q7, and Q8. As in the second year, the simulation course did not impact the communication with senior fellow (Q15). Although the simulation course did not change the self-assessment of how the students perceive periodic update plan using simulation (Q18) and the impact of team training in the clinical practice (Q19), almost all the students agreed (before and after the course) that a systematic simulation plan should be defined, and that simulation improves clinical practice.

In the **fourth year**, the simulation course did not impact very few questions. As in the third year, the neuromuscular block's importance (Q2.4) was one of them. Almost all the students disagreed with question Q11 regarding knowledge: in this year, residents assumed to have a sufficient level of knowledge, even before this year's simulation course. It is imperative to underline that students assumed that the role of the simulation was crucial as a complement of the residency (Q17), to be used in periodic update plan (Q18), in the team training in the clinical practice (Q19), and the clinical evolution of the patients (Q20).

After this analysis of the impact of simulation modules per year, we performed a complementary analysis to understand how the actual clinical practice impacted the same questions. This analysis was based on the comparisons between self-assessment *after the simulation module* with *before next year's simulation module*. As the simulation modules were performed in the first trimester, we analyzed years I-II, II-III, and III-IV.

During the first year of clinical practice as Anesthesiology residents, the students' self-assessment regarding their training about emergencies in the clinical practice did not change (Q3.3). Although they should train some emergency procedures this year, it was not sufficient to change their self-assessment. It was very interesting to observe that the students attributed less importance to the advanced airway, ventilatory monitoring, cardiac monitoring, and neuromuscular blocking monitoring at the end of the first residency year. Regarding the advanced airway, it could be related to the accumulated experience of one year in a general field until reaching Anesthesiology. Also, and since first-year residents do not make decisions alone, they do not face the enormous risk of airway management, leaving only the trust associated with the repetition of control situations. Cardiac monitoring is a routine technique, and therefore residents attributed less importance to it. Although neuromuscular blocking should be performed in clinical practice, it is not performed frequently. This justifies the lack of importance attributed to this issue by the first-year residents in Anesthesiology.

The most marked decrease in the self-assessment is associated with critical events training. This may be justified by the gain of conscientiousness of their limitations: the students were unaware of the skills about emergencies and their lack of proficiency (unconscious incompetence) and gained consciousness of their incompetence (second stage of competency).

During the second year of the residency, there were two main pedagogic contents in which students did not change the attributed importance: airway (Q2.1) and ventilatory monitoring (Q2.2) and the experience in advanced airway (Q4.1) and advanced life support (Q4.2). The self-assessment level was high, which may be because these three pedagogic contents were mainly approached during the first year of residency.

As in the first year, there was also some increase in awareness of their limitation indicated by the decreased self-assessment of specific questions, such as Q1, Q3.3, Q3.4, and Q4.4. All these questions are related to emergencies and critical events and demonstrate that second-year students are aware of their limitations in these crucial areas of the Anesthesiology field.

In the third year, students have already learned the importance of the four issues evaluated in the questionnaires. Nevertheless, questions about training (Q3) and experience (Q4) were notable for decreasing the self-assessment. We can conclude that the first three years of the Anesthesiology residency are not sufficient for the students to achieve conscious competence.

When considering the global educational process, evaluated by the questionnaire pre-year I compared with the questionnaire post-year IV, all the questions presented a significantly positive evaluation. The only question without significant differences was Q3.2, which pertains to the importance attributed by the students to cardiac monitoring and that had, from the beginning, a high value of self-assessment.

A critical point to highlight is that the questions about the importance of simulation (Q17, Q18, Q19, and Q20) increased over the years, reaching the maximum at the beginning of the fourth year. This result was sustained until the end.

Until his point, we have focused on the questions regarding the students' self-assessment of their training/experience/behavior and the importance of simulation. According to the pedagogic content taught in each specific module of simulation training, students were asked to answer another group of questions in which they evaluated the impact of the simulation training on each matter. These questions were only answered at the end of the simulation. As discussed in Chapter 6, students attributed high values for all matters trained in the simulation room. Together with the previously discussed, these results contribute to strengthening the importance of complementary simulation training.

These simulation courses are unique in Portugal since they complement a National Pedagogical Plan for Anesthesiology residents with the primary goal of including simulation training in all residency programs in Anesthesiology. The complexity of Anesthesiology, particularly related to its technological complexity and the teams' experience and competencies, applies to other areas of medicine, namely Obstetrics and Internal Medicine. There are very few studies in which the role of simulation is self-assessed by the participants.

A previous publication established that simulation training increased residents' and consultants' confidence level in Gynecology/Obstetrics. The main changes were verified in the factors that trainees associate to human reliability, confidence level to solve obstetric emergencies, and an increase in the value/importance attributed to simulation (9.3 Appendix III – The Importance of Simulation in Team Training on Obstetric Emergencies: Results of the First Phase of the National Plan for Continuous Medical Training).[149] Another recent study involving Internal Medicines Residents, also based on self-evaluation of the performance during simulation training, showed that almost all the residents strongly agreed that all learning objectives were met. The simulation was appropriate for their level of training and helpful in their clinical practice.[150]

Thus, although our study contents were based on the recommendations of the Portuguese College of Anesthesiology, our results could be also interpreted considering the impact of simulation in medical education, namely non-technical skills.

7.2 Limitations

This work was a quantitative study of medical education research based on different evaluation tools: 1) evaluating Anesthesiology trainees' performance in the communication of an adverse event in a mixed realism simulation context and 2) evaluating student's self-assessment by questionnaires provided before and after the simulation training modules. There is an inherent limitation to both evaluations: by using simulation, we do not know how realistic the environment is to the learner.

In the second part of the work, our research question was designed to be sufficiently narrow to reduce potential confounders and the variations on the measures since we wanted to address the impact, not of general simulation training, but specific simulation training designed according to the pedagogical content. Notwithstanding, and as in all studies, there is a possible bias regarding data interpretation.

The proximity between before and after simulation modules makes the changes attributable to the simulation course. Nevertheless, some confounders could influence the results. Possible confounders are how the theme is presented, the empathy between resident and Senior Consultant who is presenting the theme, and the affinity of each resident to the presented theme.

As a quantitative study, the two main biases associated are the Halo effect and the Hawthrone effect.[46] In the halo effect, the participant's perception concerning a subject could affect their perception more broadly.[152]
Moreover, supervision is one of the most influential medical education variables.[151] Empathy with the Responsible of the module is an intrinsic variable, difficult to control. Nevertheless, to avoid the halo effect related to the questions, explaining the rationale of the questions and the scale should be performed during the debriefing session.[46]
The other effect that contributes to bias is the Hawthrone effect: students who participate in the simulation courses are more prone to learn, and the simple act of participating in a course can be enough to change their behavior.[153] Nevertheless, this could depend on the realism that the students attribute to the simulated event. However, and despite the difficulty in quantifying the magnitude of this effect in the behavior, it is essential to consider it when interpreting and discussing medical education research studies.

One of the needs of medical education is to address the impact of simulation in healthcare processes and outcomes, namely in patients.[46] This would correspond to Kirkpatrick level 4 of intervention, as described in Chapter 1.[46] This is the major limitation of our study. In this type of evaluation, we can only evaluate accurately the participants' reaction (Level 1) and the learning of the skills (Level 2). Since we applied the questionnaires before and after the simulation modules, the skills learning was evaluated in the simulation environment, but we also tried to analyze the learning in the clinical setting. For the study of the other levels (3 and 4), we would have needed to design a different study with the power to detect the effects of educational intervention. It should be based not only on self-assessment but also in the follow-up of participants in their daily clinical practice. Therefore, in the context of the Translational science framework, we will need to address levels T2 and T3, translate the knowledge of the simulation room to the clinic, and ultimately to the community.[148]

Finally, and as research involving human beings, medical education research studies are delicate and multifaceted, and therefore a significant number of possible sources of intrinsic bias should be addressed. Nevertheless, it is crucial to recognize the complexity of these studies, acknowledging that it is impossible to control all the variables associated with health professional education transformation.[154]

7.3 What has changed in the last ten years? Future perspectives

When searching the PubMed database, the first publication that appears using the search criteria *Simulation training in Anesthesiology Medical Education* goes back to 1987, which focus on the description of a general anesthesia simulator.[155] Since then, approximately 758 research articles were published in this field being three-quarters published since 2011, the date when we started our study, almost ten years ago.

In Portugal, the first formal structured simulation center dates back to 2003.[96] The number of simulation centers in Portugal has been increasing, and at the moment approximately 15 simulation centers exist. Beyond the number of simulation centers, research in biomedical simulation has also increased with Academic Thesis and Scientific publication in Indexed Journals (9.4 Appendix IV – Biomedical Simulation: Evolution, Concepts, Challenges and Future Trends).[96] The presented study has two main novelties compared to the ones already published:

1. The simulation courses were designed according to the pedagogic contents of the Anesthesiology residency;
2. The results showed the self-assessment of the students.

Assessment is a part of the most significant education events, since besides the establishment of competency levels it is one of the most powerful drivers for learning.

The gaps of simulation regarding the ambiguous field of action, quality of research, impact in patient safety and clinical outcomes, resistance to its use, and the clarity of its role poses fundamental challenges that are still acknowledged. Notwithstanding, its implementation in medical education is inevitable. Nevertheless, this methodology should follow standards, and the criteria should be well defined based on the best practices evidenced in the literature and adapted according to each institution's singularities.

The positive effect showed in the students' self-assessment in technical and non-technical skills demonstrated that this simulation course format should be applied on a large scale to all Anesthesiology residents as an integral part of the residency program. The Society for Simulation in Europe has a Leadership Academy proposal aiming to develop simulation leadership across Europe. With this basis, a proposal for implementing a Pedagogic Plan in Portugal would be available and included in all Portuguese Residency Programs (Figure 7.1). In order to achieve this goal, a strong and established national collaboration is crucial to the continuous development and refinement of the course content. This National Plan should keep the vision of a robust national collaboration based on the common good and:

- Create a multidisciplinary and multicentric program to train the trainers;
- Include complementary resources, such as e-learning, to bridge the gaps between training, making it more effective;
- Assess professionals and organization performance gaps and training needs.

Finally, and in line with our studies, it is fundamental to fine-tune the validated tools and create others allowing the global evaluation of the simulation educational effect.

Who

- Anesthesiology residents

How

- Faculty
- Mentors
- Leadership Academy

Materials

- Curriculum development
- Leadership
- Action plan

Machinery

- Simulation center roadmap
- Trainers selection
- Defined outcome expectation

Time

- 4 years program

Funding

- EU funding
- National Board of Physicians
- Portuguese Society of Anesthesiologists

What

- Residency training program

Figure 7. 1 – Proposal for the implementation of Simulation-based training in all Portuguese Residency programs.

7.4 Conclusion

In the most recent years, the impact of simulation in Medical Education has been demonstrated in different settings. However, the choice of the appropriate simulation tool for the learning objective is still a challenge. Another challenge is the quantification of the simulation impact in training.

This study contributed to this field, showing that during residency, a simulation plan designed according to the pedagogical content specific for each year enhances not only technical but also non-technical skills. Moreover, self-assessment could be a reliable method for evaluating the influence of biomedical simulation in the development of residents.

Although our study was based on the contents of an Anesthesiology residency, our results are applicable to other fields of medicine. All medical specialties would benefit from complementary training with biomedical simulation, not only in technical skills but also in team and attitude competencies.

The transversal effect of simulation in biomedical education was demonstrated in the main study of this thesis, developed by the Center of Biomedical Simulation at Coimbra, created in 2010. Nevertheless, even before creating this center, a previous study that involved simulation had been developed in collaboration with the Massachusetts General Hospital. With this study, the importance of simulation on improving communication, as non-technical skills gained emphasis. This led to the inclusion of non-technical skills in the simulation training in the Center of Biomedical Simulation. Due to the study's innovative characteristics, it was not easy to compare our results with others, notwithstanding that the positive impact of simulation as a complement of traditional education was consistently demonstrated.

Behind the use of simulation as a complement of traditional education during residency, simulation should be used as a tool for senior clinicians' refreshment. This will facilitate their training, that could be narrow, due to the limited hours for formation, clinical requirements, and divestment in this area.

Finally, the development of these simulation programs showing good results will allow for their implementation at a European scale, leveraged by the Simulation Committee of the European Society of Anesthesiology.

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Chapter 9: Appendixes

9.1 Appendix I – Questionnaires

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Choose a number:

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

Questionnaire – Module I

Dear colleague,

This questionnaire intends to assess the evolution of the participant during the training with simulation. The expected average time for completion is five minutes. All data is confidential and used for research purposes only.

The medical team of Coimbra's Biomedical Simulation Center be grateful for your cooperation.

Their fill shall be understood as an authorization to the assumptions referred above.

1. How do you assess your preparation for critical events in the OR or Emergency Room?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

2. In your opinion, how important is...

2.1... airway management?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

2.2... ventilatory monitoring?

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

____

2.3... cardiac monitoring?

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

____

2.4... neuromuscular block monitoring?

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

____

3. How do you evaluate your training ...

3.1... in difficult airway management?

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

____

3.2... in advanced life support?

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

____

3.3... for emergencies for emergencies in your clinical practice?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

3.4... in crisis resource management?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

4. How do you rate your expertise...

4.1... for difficult airway management?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

4.2... in advanced life support?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

4.3... for emergencies in your clinical practice?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

____

4.4... in crisis resource management?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

____

5. I've been in situations that I couldn't deal without help.

Never	Few times	Many times
☐	☐	☐

6. I call for help

Never	Few times	Many times
☐	☐	☐

7. I feel the need for support

Never	Few times	Many times
☐	☐	☐

8. I make mistakes

Never	Few times	Many times
☐	☐	☐

9. It's difficult for me to report the mistakes I make

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

10. I don't feel prepared for the responsibility I have

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

11. I don't have enough knowledge for the responsibility I have

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

12. I don't have enough training for the responsibility I have

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

13. I don't have enough experience for the responsibility I have

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

14. I feel bad when I call for help

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

15. When I disagree with the consultant anesthesiologist opinion, I don’t express that position.

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

16. The behavioural component is crucial in the clinical setting

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

17. Simulation team training is an important complement to the residency program

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

18. A regular simulation update plan should be defined

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

19. Simulation team training improves clinical daily practice

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

20. Simulation team training have an impact on patients' clinical outcome

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

Course evaluation

Pedagogical content

21. Basic Pharmacology in Anesthesiology
    Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

22. Basic and advanced airway
    Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

23. Ventilation
    Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

24. Vascular cannulation in anesthesia
Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

25. Ultrasound in anesthesia
Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

26. Central and peripheral cannulation using ultrasound
Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

27. Neuroaxial anesthesia and local anesthetics
Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

28. Simulation training on operation room - clinical cases

28.1 Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

28.2 Formative impact

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

29. Simulation training on post-anesthesia care unit - clinical cases

29.1 Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

29.2 Formative impact

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

30. Etiology and prevention of cardio-respiratory arrest

Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

31. Basic Life Support (BLS) algorithm

Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

32. Advanced Life Support (ALS) algorithm

Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

33. Recognition of rhythms

Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

34. Defibrillation

Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

35. Simulation training on ALS - clinical cases

35.1 Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

35.2 Formative impact

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

36. Global evaluation

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

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Choose a letter:

A B C D E F G H I J L M N O P Q R S T

Questionnaire – Module II

Dear colleague,

This questionnaire intends to assess the evolution of the participant during the training with simulation. The expected average time for completion is five minutes.

All data is confidential and used for research purposes only.

The medical team of Coimbra's Biomedical Simulation Center be grateful for your cooperation.

Their fill shall be understood as an authorization to the assumptions referred above.

1. How do you assess your preparation for critical events in the OR or Emergency Room?

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

____

2. In your opinion, how important is...

2.1... airway management?

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

____

2.2... ventilatory monitoring?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

2.3... cardiac monitoring?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

2.4... neuromuscular block monitoring?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

3. How do you evaluate your training...

3.1... in difficult airway management?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

3.2... in advanced life support?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

3.3... for emergencies for emergencies in your clinical practice?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

3.4... in crisis resource management?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

4. How do you rate your expertise...

4.1... for difficult airway management?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

4.2... in advanced life support?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

4.3... for emergencies in your clinical practice?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

4.4... in crisis resource management?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

5. I've been in situations that I couldn't deal without help.

Never	Few times	Many times
☐	☐	☐

6. I call for help

Never	Few times	Many times
☐	☐	☐

7. I feel the need for support

Never	Few times	Many times
☐	☐	☐

8. I make mistakes

Never	Few times	Many times
☐	☐	☐

9. It's difficult for me to report the mistakes I make

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

10. I don't feel prepared for the responsibility I have

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

11. I don't have enough knowledge for the responsibility I have

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

12. I don't have enough training for the responsibility I have

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

13. I don't have enough experience for the responsibility I have

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

14. I feel bad when I call for help

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

15. When I disagree with the consultant anesthesiologist opinion, I don't express that position.

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

16. The behavioural component is crucial in the clinical setting

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

17. Simulation team training is an important complement to the residency program

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

18. A regular simulation update plan should be defined

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

19. Simulation team training improves clinical daily practice

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

20. Simulation team training have an impact on patients' clinical outcome

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

Course evaluation

Pedagogical content

21. Leadership and health management

Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

22. Difficult Airway Algorithm

Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

23. Supraglottic and transcutaneous devices

Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

24. Fibroscopy principles

Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

25. Simulation training on difficult airway - clinical cases

25.1 Subject relevance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

25.2 Formative impact

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

26. Ultrasound in anaesthesiology

Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

27. Ultrasound guided regional blocks

Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

28. Simulation training on ultrasound guided regional blocks - clinical cases
28.1 Subject relevance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

28.2 Formative impact

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

29. Anesthetic approach of the burned patient
Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

30. Simulation training on the anaesthetic approach to the burned patient - clinical cases
30.1 Subject relevance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

30.2 Formative impact

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

31. Global evaluation

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

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Choose a letter:

A B C D E F G H I J L M N O P Q R S T

Questionnaire – Module III

Dear colleague,

This questionnaire intends to assess the evolution of the participant during the training with simulation. The expected average time for completion is five minutes.

All data is confidential and used for research purposes only.

The medical team of Coimbra's Biomedical Simulation Center be grateful for your cooperation.

Their fill shall be understood as an authorization to the assumptions referred above.

1. How do you assess your preparation for critical events in the OR or Emergency Room?

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

____

2. In your opinion, how important is…

2.1… airway management?

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

____

2.2… ventilatory monitoring?

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

____

2.3… cardiac monitoring?

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

2.4… neuromuscular block monitoring?

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

3. How do you evaluate your training…

3.1… in difficult airway management?

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

3.2… in advanced life support?

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

3.3… for emergencies in your clinical practice?

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

3.4... in crisis resource management?

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

3.5... in obstetric emergencies?

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

3.6... in trauma?

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

4. How do you rate your expertise...

4.1... for difficult airway management?

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

4.2… in advanced life support?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

4.3… for emergencies in your clinical practice?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

4.4… in crisis resource management?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

4.5… in obstetric emergencies?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

4.6… in trauma?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

5. I've been in situations that I couldn't deal without help.

Never	Few times	Many times
☐	☐	☐

6. I call for help

Never	Few times	Many times
☐	☐	☐

7. I feel the need for support

Never	Few times	Many times
☐	☐	☐

8. I make mistakes

Never	Few times	Many times
☐	☐	☐

9. It's difficult for me to report the mistakes I make

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

10. I don't feel prepared for the responsibility I have

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

11. I don't have enough knowledge for the responsibility I have

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

12. I don’t have enough training for the responsibility I have

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

13. I don’t have enough experience for the responsibility I have

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

14. I feel bad when I call for help

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

15. When I disagree with the consultant anesthesiologist opinion, I don’t express that position.

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

16. The behavioural component is crucial in the clinical setting

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

17. Simulation team training is an important complement to the residency program

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

18. A regular simulation update plan should be defined

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

19. Simulation team training improves clinical daily practice

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

20. Simulation team training have an impact on patients' clinical outcome

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

Course evaluation

Pedagogical content

21. Assessment of a trauma patient, head and thoracic trauma

Subject importance

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

22. Abdominal trauma
Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

23. Massive haemorrhage management
Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

24. Trauma in the pregnant woman
Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

25. Simulation training on trauma - clinical cases

25.1 Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

25.2 Formative impact

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

26. Pathophysiology and management of Acute Respiratory Distress Syndrome (ARDS)
Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

27. ARDS ventilation
Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

28. Pathophysiology of sepsis
Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

29. Management of a septic patient
Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

30. Simulation training on Intensive Care - clinical cases
30.1 Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

30.2 Formative impact

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

31. Anatomo-physiological changes of pregnancy
    Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

32. Labour analgesia
    Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

33. Obstetric Emergencies
    Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

34. Simulation training on obstetric anaesthesiology - clinical cases

34.1 Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

34.2 Formative impact

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

35. Global Evaluation

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

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Choose a letter:

A B C D E F G H I J L M N O P Q R S T

Questionnaire – Module IV

Dear colleague,

This questionnaire intends to assess the evolution of the participant during the training with simulation. The expected average time for completion is five minutes.

All data is confidential and used for research purposes only.

The medical team of Coimbra's Biomedical Simulation Center be grateful for your cooperation.

Their fill shall be understood as an authorization to the assumptions referred above.

1. How do you assess your preparation for critical events in the OR or Emergency Room?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

2. In your opinion, how important is...

... airway management?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

2.1... ventilatory monitoring?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

2.2... cardiac monitoring?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

2.3... neuromuscular block monitoring?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

3. How do you evaluate your training ...

3.1... in difficult airway management?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

3.2... in advanced life support?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

3.3... for emergencies in your clinical practice?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

3.4... in crisis resource management?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

4. How do you rate your expertise...

4.1... for difficult airway management?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

4.2... in advanced life support?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

4.3… for emergencies in your clinical practice?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

4.4… in crisis resource management?

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

5. I've been in situations that I couldn't deal without help.

Never	Few times	Many times
☐	☐	☐

6. I call for help

Never	Few times	Many times
☐	☐	☐

7. I feel the need for support

Never	Few times	Many times
☐	☐	☐

8. I make mistakes

Never	Few times	Many times
☐	☐	☐

9. It’s difficult for me to report the mistakes I make

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

10. I don’t feel prepared for the responsibility I have

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

11.I don’t have enough knowledge for the responsibility I have

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

11. I don’t have enough training for the responsibility I have

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

12. I don’t have enough experience for the responsibility I have

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

13. I feel bad when I call for help

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

14. When I disagree with the consultant anesthesiologist opinion, I don't express that position.

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

15. The behavioural component is crucial in the clinical setting

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

16. Simulation team training is an important complement to the residency program

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

17. A regular simulation update plan should be defined

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

18. Simulation team training improves clinical daily practice

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

19. Simulation team training have an impact on patients' clinical outcome

Strongly disagree	Partially disagree	No opinion	Partially agree	Strongly agree
☐	☐	☐	☐	☐

Course evaluation

Pedagogical content

20. Effective communication

Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

21. Crisis Resource Management in Anaesthesiology (ACRM)

Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

22. ACRM principle

Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

24. Simulation training on ACRM - clinical cases

24.1 Subject importance

Null										Maximum
0	1	2	3	4	5	6	7	8	9	10

24.2 Formative impact

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

____

23. Emergencies in the OR

Subject importance

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

____

24. Simulation training OR emergencies: clinical cases

26.1 Subject importance

Null Maximum

0 2 3 4 5 6 7 8 9 10

____

26.2 Formative impact

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

____

25. Global evaluation

Null Maximum

0 1 2 3 4 5 6 7 8 9 10

____

9.2 Appendix II – Scenario Scripts

Plano Pedagógico Nacional
INTERNATO DE ANESTESIOLOGIA

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de Coimbra

Scenario script

Clinical case: anaphylaxis

Major problem	**Medical component** Approach to the critical patient in the Emergency Room Approach to a patient with a severe allergic reaction	**CRM** - Systematic approach - Teamwork
Final objectives	**Medical component** - Show skills as a team leader - Diagnosis and treatment of the critical patient/asthma crisis - Collects information and performs a detailed clinical observation - Administers oxygen and monitors the patient	**CRM** - Safe and efficient approach - Leadership - Communication - Distribution of tasks - Repeated re-evaluation
Narrative description	Male patient (Alberto Cruz) 63 years-old, underwent a total knee prosthetic placement surgery under general anaesthesia. As prior diseases he had medically controlled hypertension (furosemide and hydrochlorothiazide) as well as prostatic hyperplasia. Smoker for 40 years. He had been in the post-anaesthetic care ward for 15 minutes. A blood transfusion was being administered. Suddenly he started feeling restless and progressed to dyspnoea with respiratory distress. The nurse then calls for the doctor.	
Scenario team	**Operator:** **Scenario director:** **Instructors:** **Actors:**	**Participants** Two Anaesthesiologists One Anaesthesiology intern
Introduction to the scene	**All of the participants** The anaesthesiology intern is called because one of the patients in the post anaesthetic care ward is feeling breathlessness. The patient has just been placed in the ward, the anaesthesia had no complications, and he is not bleeding excessively	**"Key positions"** One of the elements of the team
Preparing the setting and environment	**Environment in the PACW** Patient lying in the PACW bed. Central venous catheter in the right internal jugular vein connected to a normal saline and one unit of red blood cells as well as a PCA with morphine. On the other arm, there is a peripheral access where an antibiotic is being administered. The knee has a drain with 300 ml of blood. Urinary catheter with 500 of clear urine. Another patient is on the bed beside him. He has had a laparoscopic cholecystectomy and is complaining of pain.	

Scenario "life-savers"	If they do not diagnose anaphylaxis, the patient lying on his side says that his brother once became like that after some antibiotics. If they do not administer adrenaline, the nurse may suggest this at a more advanced stage. If the intern does not ask the remaining team for help, the nurse takes that initiative.

Scenario objectives and key points of the debriefing

Medical component	ACRM
Anaphylaxis diagnosis: talk to the patient, collect clinical data, uncover to look at the patient, monitor, auscultate **Anaphylaxis treatment:** Stop medication, oxygen, fluids, consider adrenaline, consider other medication (corticoids)	Leadership Communication Using all the information Cognitive support Verify, confirm and revaluate

Narrative description of the scenario

Male patient (Alberto Cruz) 63 years-old, underwent a total knee prosthetic placement surgery under general anaesthesia. As prior diseases he had medically controlled hypertension (furosemide and hydrochlorothiazide) as well as prostatic hyperplasia. Smoker for 40 years. He had been in the post-anaesthetic care ward for 15 minutes. A blood transfusion was being administered. Suddenly he started feeling restless and progressed to dyspnoea with respiratory distress. The nurse then calls for the doctor.

Initially the patient has a HR 90; BP 116/52; RF 36; O2Sat 92%; Pulmonary auscultation with wheezing; Normal Cardiac auscultation; Anxious, complaining of chest pain.

Moderate anaphylaxis: HR 105; BP 100/42; RF 40; O2Sat 82%; Pulmonary auscultation with wheezing; Cardiac auscultation with tachycardia; Anxious, coughing.

Worsening: HR 125; BP 96/35; O2Sat 78%; "Can't... Breathe..."

Severe anaphylaxis: HR 135; BP 82/36; O2Sat 60%; Lung auscultation with wheezing; Doesn't respond.

Team

Actors	Nurse	Patient by his side		
Instructors	Instructor 1	Instructor 2		
Participants	Anaesthesia resident	Anaesthesiologist 1	Anaesthesiologist 2	

Scenario summary: Information for all participants

Patient lying in the PACW bed. Already monitored. Central venous catheter in the right internal jugular vein connected to a normal saline and one unit of red blood cells as well as a PCA with morphine and ampicillin. Becomes restless and complains of chest pain. Drain in the knee without significant haemorrhage. Recently submitted to Knee prosthetic placement surgery.

Preparing the scenario

The knee has a drain with 300 ml of blood. Urinary catheter with 500 of clear urine.
He is monitored.
Another patient is on the bed beside him. He has had a laparoscopic cholecystectomy and is complaining of pain.
Patient information with his clinical data from the surgery (orthopaedic and anaesthetic), blood tests (Haemoglobin pre op 12g/dL), Blood type A Rh-.

- Anaesthetic sheet (General anaesthesia, orotracheal intubation, urinary catheter; seven central venous catheter in the right internal jugular + seven peripheral access in the left superior limb (administered omeprazole 40, parecoxib 40 and metoclopramide). Some blood pressure spikes (especially at the end of the surgery). Duration 1.30h-2h.
- Acute pain unit sheet (perfusion and bolus of morphine)
- Drain with 300 ml of blood, started a perfusion of ampicillin, oxygen through a nasal mask, vital signs, ice on the knee
- Requested a hemogram and biochemistry panel

Preparing the simulator

Environment in the PACW
Patient lying in the PACW bed. Central venous catheter in the right internal jugular vein connected to a normal saline and one unit of red blood cells as well as a PCA with morphine. On the other arm, there is a peripheral access where an antibiotic is being administered. The knee has a drain with 300 ml of blood. Urinary catheter with 500 of clear urine.
Another patient is on the bed beside him. He has had a laparoscopic cholecystectomy and is complaining of pain.

Simulator activity during the scenario

Initially the patient has a HR 90; BP 116/52; RF 36; O2Sat 92%; Pulmonary auscultation with wheezing; Normal Cardiac auscultation; Anxious, complaining of chest pain.

Moderate anaphylaxis: HR 105; BP 100/42; RF 40; O2Sat 82%; Pulmonary auscultation with wheezing; Cardiac auscultation with tachycardia; Anxious, coughing.

Worsening: HR 125; BP 96/35; O2Sat 78%; “Can’t… Breathe…”

Severe anaphylaxis: HR 135; BP 82/36; O2Sat 60%; Lung auscultation with wheezing; Doesn’t respond.

Administered adrenaline: HR 180, BP 100/60; O2Sat 60%.

Improvement: HR 116; BP 110/70; RR 36; O2Sat 90%.

Debriefing planning (guided by the learning objectives and checklists)

Medical component	**Group**	**Group**	**Group**	**Group**
Systematic approach to the urgent/emergent patient				
1. ABCDE approach				
2. Identify the critical patient				
3. Ask for help				
Performance				
1. Anaphylaxis diagnosis				
2. STOP stimulus				
3. Prioritises the administration of adrenaline				
4. Support measures (O2)				
5. Other drugs (corticoids, antihistamines)				
Anticipate potential problems				
1. Think of intubating				
CRM				
1. Leadership				
2. Communication				
3. Using all the information				
4. Cognitive support				
5. Verify, confirm and revaluate				

Scenario script

Clinical case: anaesthetic induction in a patient with CKD – part 1

<table>
<tr><td>Major problem</td><td>Medical component
67-year-old patient proposed to place external fixation due to a pelvic fracture after a driving accident.</td><td>ACRM
- Leadership
- Distribute tasks
- Unknown environment</td></tr>
<tr><td>Final objective</td><td>Medical component
Know which drugs to select on an anaesthetic induction on an ASA III patient as an urgent situation.</td><td>ACRM
- Leadership
- Distribute tasks
- Unknown environment
- Use all of the information</td></tr>
<tr><td>Narrative description</td><td colspan="2">- 67-year-old male patient, ASA III with asthma and chronic renal insufficiency – CKD on HD – dialysis three times per week.
- Driving accident as he was going to his dialysis session. Need for an urgent surgery to correct a pelvic fracture.
- Blood tests: Hg 7.2 g/dL, Creatinine 3.8, K^+ 6.2.</td></tr>
<tr><td>Scenario team</td><td>Operator:
Scenario director:
Instructors:
Actors: Nurse</td><td>Participants
Three anaesthesiology interns</td></tr>
<tr><td>Preparing the place and environment</td><td colspan="2">The scenario takes place at the OR. The simulator is dressed in a shirt with a peripheral access.
Monitored with two derivation EKG, O2Sat and non-invasive BP. Monitorization of muscular relaxation is available and should only be supplied if requested.
Near the monitor is the patient file, anaesthetic file and post anaesthesia care ward registry sheet. In the room there should exist the necessary emergency drugs and muscular relaxation antagonists.
Induction with succinylcholine -> Ventricular tachycardia and ventricular fibrillation.</td></tr>
<tr><td>Scenario “life-savers”</td><td colspan="2">Anaesthesia nurse.</td></tr>
</table>

Scenario objectives and key points of the debriefing

Medical component	CRM
- Know which drugs to select in an ASA III patient - Know how to approach an airway – select gadgets according to the clinical situation - Know how to keep the patient under anaesthesia - Know how to identify potential risks - Use auxiliaries to monitor anaesthetic depth and muscular relaxation	- Leadership - Communication - Using all of the information - Cognitive support - Verify, confirm and re-evaluate

Narrative description of the scenario

- 67-year-old male patient, ASA III with asthma and chronic renal insufficiency – CKD on HD – dialysis three times per week.
- Driving accident as he was going to his dialysis session. Need for an urgent surgery to correct a pelvic fracture
- Blood tests: Hg 7.2 g/dL, Creatinine 3.8; K 6.2.

Team

Actors	Nurse		
Instructors	Instructor 1		
Participants	Doctor 1	Doctor 2	Doctor 3

Scenario summary: Information for all participants

67-year-old male patient, ASA III with asthma and chronic renal insufficiency – CKD on HD – dialysis three times per week. Driving accident as he was going to his dialysis session.
Need for an urgent surgery to correct a pelvic fracture.

Preparing the scenario

The scenario takes place at the OR. The simulator is dressed in a shirt with a peripheral access.
Monitored with two derivation EKG, O2Sat and non-invasive BP. Monitorization of muscular relaxation is available and should only be supplied if requested.
Near the monitor is the patient file, anaesthetic file and post anaesthesia care ward registry sheet. In the room there should exist the necessary emergency drugs and muscular relaxation antagonists.

Preparing the simulator

The scenario takes place at the OR. The simulator is dressed in a shirt with a peripheral access.
Monitored with two derivation EKG, O2Sat and non-invasive BP.

Simulator activity during the scenario

The scenario takes place at the OR. The simulator is dressed in a shirt with a peripheral access.
Monitored with two derivation EKG, O2Sat and non-invasive BP.
Conscious, nervous, agitated, complaining of pain.
BP 145/61; HR 98bpm.
Patient denies allergies, says that he hasn't eaten since breakfast (1hour ago), two croissants with ham and milk with coffee. Choice of anaesthetic drugs according to the hemodynamic status and comorbidities.
If induced with succinylcholine -> ventricular tachycardia and ventricular fibrillation.

Debriefing planning (guided by the learning objectives and checklists)

Medical component	Group	Group	Group	Group
Systematic approach to the patient				
1. Know the surgery and indication				
2. Review clinical file and exams				
3. Talk to the patient to confirm fasting				
Anaesthetic induction				
1. Gather the necessary material and confirm that it works				
2. Choose the adequate induction drug				
3. Monitor anaesthetic depth and NMB				
4. Correct placement of the laryngoscope and laryngoscopy				
In case of cardiac arrest				
1. Know the algorithm				
2. Recognise the rhythms				
3. Identify causes of the arrest				
4. Correct potential causes				
CRM				
1. Leadership				
2. Communication				
3. Using all of the information				
4. Cognitive support				
5. Verify, confirm and re-evaluate				

Scenario script

Clinical case: anaesthetic induction in a patient with CKD – part 2

Major problem	**Medical component** 67-year-old patient proposed to place external fixation due to a pelvic fracture after a driving accident	**ACRM** - Leadership - Distribute tasks - Unknown environment
Final objective	**Medical component** Diagnose and treatment of a bronchospasm	**ACRM** - Leadership - Distribute tasks - Unknown environment - Use all of the information
Narrative description	67-year-old male patient, ASA III with asthma and chronic renal insufficiency – CKD on HD – dialysis three times per week. Driving accident as he was going to his dialysis session. Need for an urgent surgery to correct a pelvic fracture Blood tests: Hg 7.2 g/dL, Creatinine 3.8; K 6.2. During the anaesthesia, there is a desaturation with increased insufflation pressure.	
Scenario team	**Operator:** **Scenario director:** **Instructors:** **Actors:** Nurse	**Participants** Three anaesthesiology interns
Preparing the place and simulator	The scenario takes place at the OR. The simulator is dressed with a shirt with a peripheral access. Monitored with two derivation EKG, O2Sat and non-invasive BP. Monitorization of muscular relaxation is available and should only be supplied if requested. Near the monitor is the patient file, anaesthetic file and post anaesthesia care ward registry sheet. In the room there should exist the necessary emergency drugs and muscular relaxation antagonists. Already induced patient, surgery is already undergoing, maintenance therapy with desflurane. There is a sudden desaturation with an increase in insufflating pressure. Lung auscultation: homolateral wheezing on the right hemithorax.	
Scenario "life-savers"	Anaesthesia nurse reminds that the patient is asthmatic.	

Scenario objectives and key points of the debriefing

Medical component	CRM
- Know how to keep the patient under anaesthesia. - Use auxiliaries to monitor anaesthetic depth and muscular relaxation. - **Bronchospasm diagnosis and approach:** Collect patient clinical data, observe the patient, verify airway, evaluate breathing (RR, cyanosis, wheezing). Review monitoring. Feel for pulses, verify BP, auscultate, monitor. - **Treating bronchospasm:** O2, increase anaesthetic depth, nebulization with salbutamol and ipratropium bromide. Consider corticoids, aminophylline, remove all of the drugs that may remove bronchospasm. Re-evaluate. Repeat measures.	- Leadership - Communication - Coordination - Teamwork - Using all of the information - Cognitive support - Verify, confirm and re-evaluate

Narrative description of the scenario

- 67-year-old male patient, ASA III with asthma and chronic renal insufficiency – CKD on HD – dialysis three times per week.
- Driving accident as he was going to his dialysis session. Need for an urgent surgery to correct a pelvic fracture
- Blood tests: Hg 7.2 g/dL, Creatinine 3.8; K 6.2.

Already induced patient, surgery is already undergoing, maintenance therapy with desflurane. There is a sudden desaturation with an increase in insufflating pressure.

Lung auscultation: homolateral wheezing on the right hemithorax.

Team

Actors	Nurse		
Instructors	Instructor 1		
Participants	Doctor 1	Doctor 2	Doctor 3

Scenario summary: Information for all participants

- 67-year-old male patient, ASA III with asthma and chronic renal insufficiency – CKD on HD – dialysis three times per week.
- Driving accident as he was going to his dialysis session. Need for an urgent surgery to correct a pelvic fracture.
- Surgery is already undergoing.

Preparing the scenario

The scenario takes place at the OR. The simulator is dressed in a shirt with a peripheral access.
Monitored with two derivation EKG, O2Sat and non-invasive BP. Monitorization of muscular relaxation is available and should only be supplied if requested
Near the monitor is the patient file, anaesthetic file and post anaesthesia care ward registry sheet. In the room there should exist the necessary emergency drugs and muscular relaxation antagonists.

Preparing the simulator

The scenario takes place at the OR. The simulator is dressed in a shirt with a peripheral access.
Monitored with two derivation EKG, O2Sat and non-invasive BP.
The patient is under anaesthesia and ventilated with O2Sat in a descending pattern. Peak pressure >35cmH2O. Lung auscultation: homolateral wheezing on the right hemithorax.

Simulator activity during the scenario

The patient is under anaesthesia and ventilated with O_2Sat in a descending pattern.

Lung auscultation: homolateral wheezing on the right hemithorax.

Blood gas test with increase in CO_2.

Thoracic X-ray should be requested.

The participants should:
- Increase FiO_2 to 100%
- Nebulization with salbutamol and ipratropium bromide
- Hydrocortisone 100mg IV
- Adrenaline 0.01mg IV or 0.5 mg IM
- Stop desflurane -> Start sevoflurane or ketamine
- Aminophylline IV

Differential diagnosis with laryngospasm, pneumothorax, gastric content aspiration, selective orotracheal intubation.

If the measures are not performed the patient will continue desaturating with increase in peak pressures.

Debriefing planning (guided by the learning objectives and checklists)

Medical component	Group	Group	Group	Group
Systematic approach to the patient				
1. Know the surgery and indication				
2. Review clinical file and exams				
Identify the problem				
1. Increase FiO_2				
2. Airway approach – Confirm tube positioning				
3. Identify bronchospasm				
4. Increase anaesthetic depth				
5. Remove bronchospasm inducing drugs				
6. Administer bronchodilators and corticoids				
7. Other measures (aminophylline, IM adrenaline)				
8. Ask for blood gas tests and perform a thoracic x-ray				
9. Think of the possible differential diagnosis				
CRM				
1. Ask for help				
2. Communication				
3. Leadership				
4. Distributing tasks				
5. Anticipate				

Scenario script

Clinical case: anesthetic induction in a patient with HT and DM

<table>
<tr><td>Major problem</td><td>Medical component
67-year-old patient proposed for a programmed hemicolectomy due to a right colon cancer</td><td colspan="2">ACRM
- Leadership
- Distribute tasks
- Unknown environment</td></tr>
<tr><td>Final objectives</td><td>Medical component
Know which drugs to select for anaesthetic induction on an ASA II patient</td><td colspan="2">ACRM
- Leadership
- Distribute tasks
- Unknown environment
- Use all of the information</td></tr>
<tr><td>Narrative description</td><td colspan="3">- 67-year-old male patient, ASA II with medicated and controlled diabetes mellitus and hypertension.
- Chronically medicated with metformin 2id and an association of losartan and hydrochlorothiazide.
- Proposed for a right hemicolectomy due to colon cancer. Premedicated with 7.5mg of midazolam orally.
- All of the exams had no changes.</td></tr>
<tr><td>Scenario team</td><td>Operator:
Scenario director:
Instructors:
Actors: Nurse</td><td colspan="2">Participants
Three anaesthesiology interns</td></tr>
<tr><td>Preparing the place and environment</td><td colspan="3">The scenario takes place at the OR. The simulator is dressed in a shirt with a peripheral access.
Monitored with two derivation EKG, O2Sat and non-invasive BP. Monitorization of muscular relaxation is available and should only be supplied if requested.
Near the monitor is the patient file, anaesthetic file and post anaesthesia care ward registry sheet. In the room there should exist the necessary emergency drugs and muscular relaxation antagonists.</td></tr>
<tr><td>Scenario “life-savers”</td><td colspan="3">Anaesthesia nurse.</td></tr>
</table>

Scenario objectives and key points of the debriefing

Medical component	CRM
- Know which drugs to select in an ASA II patient - Know how to approach an airway – select gadgets according to the clinical situation - Know how to keep the patient under anaesthesia - Use auxiliaries to monitor anaesthetic depth and muscular relaxation	Leadership Communication Using all of the information Cognitive support Verify, confirm and re-evaluate

Narrative description of the scenario

- 67-year-old male patient, ASA II with medicated and controlled diabetes mellitus and hypertension.
- Chronically medicated with metformin 2id and an association of losartan and hydrochlorothiazide
- Proposed for a right hemicolectomy due to colon cancer. Premedicated with 7.5mg of midazolam orally.

Team

Actors	Nurse		
Instructors	Instructor 1		
Participants	Doctor 1	Doctor 2	Doctor 3

Scenario summary: Information for all participants

- 67-year-old male patient, ASA II with medicated and controlled diabetes mellitus and hypertension.
- Chronically medicated with metformin 2id and an association of losartan and hydrochlorothiazide.
- Proposed for a right hemicolectomy due to colon cancer. Premedicated with 7.5mg of midazolam orally.
- Patient file, blood tests and exams are in the OR.

Preparing the scenario

The scenario takes place at the OR. The simulator is dressed in a shirt with a peripheral access.
Monitored with two derivation EKG, O2Sat and non-invasive BP. Monitorization of muscular relaxation is available and should only be supplied if requested.
Near the monitor is the patient file, anaesthetic file and post anaesthesia care ward registry sheet. In the room there should exist the necessary emergency drugs and muscular relaxation antagonists.

Preparing the simulator

The scenario takes place at the OR. The simulator is dressed in a shirt with a peripheral access.
Monitored with two derivation EKG, O2Sat and non-invasive BP. Monitorization of muscular relaxation is available and should only be supplied if requested

Simulator activity during the scenario

Patient is fine, sleepy
BP 135/67mmHg HR 68 bpm
→ Airway should be evaluated previously to discart a possibly difficult airway.
After administering induction drugs the patient loses consciousness and respiratory drive. BP 110/56mmHg. HR 66bpm

- ➔ OTI should be performed, followed by a confirmation of tubing position and connexion to the ventilator
- ➔ Anaesthetic maintenance should be initiated

Debriefing planning (guided by the learning objectives and checklists)

Medical component	**Group**	**Group**	**Group**	**Group**
Systematic approach to the patient				
1. Know the surgery and indication				
2. Review clinical file and exams				
3. Talk to the patient to confirm fasting				
Anaesthetic induction				
1. Gather the necessary material and confirm that it works				
2. Choose the adequate induction drug				
3. Monitor anaesthetic depth and NMB				
4. Correct placement of the laryngoscope and laryngoscopy				
CRM				
1. Leadership				
2. Communication				
3. Using all of the information				
4. Cognitive support				
5. Verify, confirm and re-evaluate				

Scenario script

Clinical case: anaesthetic induction in a patient with anxiety

<table>
<tr><td>Major problem</td><td>Medical component
Male, 35-year-old patient proposed for a varicocele.</td><td>ACRM
- Leadership
- Distribute tasks
- Unknown environment</td></tr>
<tr><td>Final objective</td><td>Medical component
Know which drugs to select and use on an anesthetic induction of an ASA II patient with a panic attack.</td><td>ACRM
- Leadership
- Distribute tasks
- Unknown environment
- Use all of the information</td></tr>
<tr><td>Narrative description</td><td colspan="2">35-year-old male patient. ASA II with previously diagnosed anxiety. Chronically medicated with alprazolam 1mg three times daily. Proposed for an elective varicocele correction.
He was not premedicated because he was only admitted today.
Exams without any problems.</td></tr>
<tr><td>Scenario team</td><td>Operator:
Scenario director:
Instructors:
Actors: nurse</td><td>Participants
Three Anesthesiology interns</td></tr>
<tr><td>Preparing the place/simulator</td><td colspan="2">The scenario takes place at the OR. The simulator is dressed in a shirt with a peripheral access.
Monitored with two derivation EKG, O2Sat and non-invasive BP. Monitorization of muscular relaxation is available and should only be supplied if requested.
Near the monitor is the patient file, anesthetic file and post anesthesia care ward registry sheet. In the room there should exist the necessary emergency drugs and muscular relaxation antagonists
Very anxious patient with a panic attack, describing claustrophobia and that he wants to leave. The patient is extremely uncomfortable.</td></tr>
<tr><td>Scenario “life-savers”</td><td colspan="2">Anesthesia nurse – If no one asks, the nurse asks the patient if he has already eaten anything.</td></tr>
<tr><td>Predicted approach</td><td colspan="2">Try to communicate with the patient to calm him down.
While that is not possible, try to sedate the patient by administering an anxiolytic drug (midazolam IV, etc.).
Select drugs for a quick induction sequence. If this selection is not adequate the patient vomits with risk of gastric content aspiration.</td></tr>
</table>

Scenario objectives and key points of the debriefing

Medical component	CRM
- Know which drugs to select in an ASA II patient - Know how to approach an airway – select gadgets according to the clinical situation - Use auxiliaries to monitor anesthetic depth and muscular relaxation - Understand that he has a full stomach - Approach the airway with a quick induction sequence	- Leadership - Distribute tasks - Communication - Using all of the information - Cognitive support - Verify, confirm and re-evaluate

Narrative description of the scenario

- 35-year-old male patient. ASA II with previously diagnosed anxiety. Chronically medicated with alprazolam 1mg three times daily. Proposed for an elective varicocele correction
- He was not premedicated because he was only admitted today

Exams without any problems Very anxious patient with a panic attack, describing claustrophobia and that he wants to leave. The patient is extremely uncomfortable.

Team

Actors	Nurse		
Instructors	Instructor 1		
Participants	Doctor 1	Doctor 2	Doctor 3

Scenario summary: Information for all participants

- 35-year-old male patient. ASA II with previously diagnosed anxiety. Chronically medicated with alprazolam 1mg three times daily. Proposed for an elective varicocele correction.
- He was not premedicated because he was only admitted today.
- Exams without any problems.

Preparing the scenario

The scenario takes place at the OR. The simulator is dressed in a shirt with a peripheral access.
Monitored with two derivation EKG, O2Sat and non-invasive BP. Monitorization of muscular relaxation is available and should only be supplied if requested
Near the monitor is the patient file, anaesthetic file and post anaesthesia care ward registry sheet. In the room there should exist the necessary emergency drugs and muscular relaxation antagonists

Preparing the simulator

The scenario takes place at the OR. The simulator is dressed in a shirt with a peripheral access.
Monitored with two derivation EKG, O2Sat and non-invasive BP. Monitorization of muscular relaxation is available and should only be supplied if requested.
Very anxious patient with a panic attack, describing claustrophobia and that he wants to leave. The patient is extremely uncomfortable.

Simulator activity during the scenario

Very anxious patient with a panic attack, describing claustrophobia and that he wants to leave. The patient is extremely uncomfortable. Vital signs stable. Try to communicate with the patient to calm him down. Since he will not calm down, try to sedate the patient by administering an anyolite (midazolam IV, etc.) → Select drugs for a quick induction sequence. If this selection is not adequate the patient vomits with risk of gastric content aspiration.

Debriefing planning (guided by the learning objectives and checklists)

Medical component	**Group**	**Group**	**Group**	**Group**
Systematic approach to the patient				
1. Know the surgery and indication				
2. Review clinical file and exams				
3. Talk to the patient to confirm fasting				
4. Try to calm down the patient				
Anaesthetic induction				
1. Gather the necessary material and confirm that it works				
2. Choose the adequate induction drug – quick sequence induction				
3. Monitor anaesthetic depth and NMB				
4. Correct placement of the laryngoscope and laryngoscopy				
5. In case of vomit – aspiration and OTI				
CRM				
1. Leadership				
2. Distribute tasks				
3. Communication				
4. Using all of the information				
5. Cognitive support				
6. Verify, confirm and re-evaluate				

Scenario script

Clinical case: asthma

Major problem	**Medical component** Approach to the critical patient in the Emergency Room Approach to a patient with an asthma crisis	**CRM** - Systematic approach - Teamwork
Final objectives	**Medical component** - Show skills as a team leader - Diagnosis and treatment of the critical patient/asthma crisis - Collects information and performs a detailed clinical observation - Administers oxygen and monitors the patient - Therapeutic attitudes	**CRM** - Safe and efficient approach - Leadership - Communication - Distribution of tasks - Repeated re-evaluation
Narrative description	Male patient, 35-years old, (João Cunha), living in Belmonte – Covilhã. As prior diseases he reports having asthma since he was a child. He was taking fluticasone chronically and salbutamol in SOS. Since the beginning of Spring, he had gotten worse of his asthma crisis. In the past two days his crisis got more and more frequent. This morning he had to use salbutamol twice without any clinical improvement. Therefore, he came to the emergency department.	
Scenario team	**Operator:** **Scenario director:** **Instructors:** **Actors:**	**Participants** Four doctors
Introduction to the scene	**All the participants** Clinical case description	**“Key positions”**
Preparing the setting and environment	**Environment in the Emergency Room.** The patient is lying in on the emergency department bed, pale, aware of his surroundings, polypneic, without intercostal retraction but with cyanosis. He is unable to complete sentences due to the harsh dyspnoea with intermittent wheezing.	
Scenario “life-savers”	- If the team does not approach the patient fast enough, the brother enters the scene with the patient’s usual inhaling medication in hand. - If the team doesn’t diagnose asthma, the brother will say that Mr. João had bronchitis since his childhood. - If the team does not approach quickly with bronchodilators and oxygen, the scenery evolves to II.	

Scenario objectives and key point of the debriefing

Medical component	ACRM
Approach and diagnosis of asthma: Collect clinical data of the patient and brother, observe the patient, verify airway, evaluate breathing (frequency, cyanosis, wheezing). Monitor peripheral saturation. Feel for pulses, verify blood pressure, auscultate, monitor. **Asthma treatment:** Oxygen, salbutamol nebulization with salbutamol and ipratropium bromide. Consider corticotherapy (oral/IV). Re-evaluate after seven dose of bronchodilators. Repeat. **Transport**: planning, information for the Hospital/Emergency Department, Safety.	Safety Leadership Communication Coordination Teamwork Using all the information Cognitive support Verify, confirm and re-evaluate

Narrative description of the scenario

Male patient, 35-years old, (João Cunha), living in Belmonte – Covilhã.
As prior diseases he reports having asthma since he was a child. He was taking fluticasone chronically and salbutamol in SOS. Since the beginning of Spring, he had gotten worse of his asthma crisis. In the past two days his crisis got more and more frequent. This morning he had to use salbutamol twice without any clinical improvement. Therefore, he came to the emergency department.
Initially his heart rate was 115 beats/min, blood pressure of 134/82mmHg. Respiratory rate of 30 cycles per minute. Peripheral oxygen saturation of 85%. Pulmonary auscultation with diffuse wheezing; Cardiac auscultation – tachycardia.
Pale, breathless, can't complete sentences. Cyanotic.

Team

Actors	Patient's brother			
Instructors	Instructor 1			
Participants	Doctor 1	Doctor 2	Doctor 3	Doctor 4

Scenario summary: Information for all participants

Patient that came to the emergency department with intense dyspnoea (wheezing), cyanosis, polypnea and cannot complete sentences.

Preparing the scenario

The patient is lying in on the emergency department bed, pale, aware of his surroundings, polypneic, without intercostal retraction but with cyanosis. Respiratory gadgets.

Preparing the simulator

Simulator: Initially his heart rate was 115 beats/min, blood pressure of 134/82 mmHg. Respiratory rate of 30 cycles per minute. Peripheral oxygen saturation of 85%. Pulmonary auscultation with diffuse wheezing; Cardiac auscultation – tachycardia. Pale, breathless, can't complete sentences. Cyanotic

Simulator activity during the scenario

Simulator: **I –** Initially his heart rate was 115 beats/min, blood pressure of 134/82 mmHg. Respiratory rate of 30 cycles per minute. Peripheral oxygen saturation of 85%. Pulmonary auscultation with diffuse wheezing; Cardiac auscultation – tachycardia. Pale, breathless, can't complete sentences. Cyanotic. **II –** If the team does not perform rapidly, the case develops into severe desaturation, bradycardia and diminished consciousness. **III –** Respiratory insufficiency with the need for OTI and MV. **IV –** Clinical situation stabilization. Transport for the ICU after planning the transport.

Debriefing planning (guided by the learning objectives and checklists)

Medical component	Group	Group	Group	Group
Systematic approach to the urgent/emergent patient				
1. ABCDE approach				
2. Identify the critical patient				
3. Ask for help				
Support measures				
1. Administer oxygen				
2. Bronchodilators				
3. Corticoids				
4. Other measures (ex. adrenaline)/ Repeat drugs				
Decision to intubate				
1. Adequate material for intubation				
2. Choosing the adequate drugs				
3. Intubation technique				
Patient forwarding				
1. Deciding where to direct the patient				
2. Describing the patient history and current state				
3. Preparing transport				
CRM				
1. Safety				
2. Leadership				
3. Communication				
4. Coordination				
5. Teamwork				
6. Using all the information				
7. Cognitive support				
8. Verify, confirm and re-evaluate				

Scenario script

Clinical case: bronchospasm after anaesthetic induction

Major problem	**Medical component** Approach to the critical patient. Approach to a patient with a severe bronchospasm.	**CRM** Systematic approach Teamwork
Final objective	Diagnosis and treatment of bronchospasm, post extubation period.	**CRM** Communication, Leadership Distribute tasks Repeated re-evaluation
Narrative description	Immediately after induction, once the anaesthesiology specialist left the OR, the patient (who was being submitted to a total nephrectomy), showed a sudden increase of respiratory pressures, a change in the capnography curve (which turned ascendant), a reduction of the tidal volume, peripheral desaturation and hypotension.	
Scenario team	**Operator:** **Scenario director:** **Instructors:** **Actors:** anaesthesia intern and nurse	**Participants** Three anaesthesiologists
Introduction to the scene	**All of the participants** Team responsible for the OR	
Preparing the place and environment	**OR scenario** Monitor, ventilator, perfusion syringe and emergency cart.	
Scenario "life-savers"	Nurse points out the desaturation and hypotension. If they don't act, the nurse suggests a salbutamol nebulization.	

Scenario objectives and key points of the debriefing

Medical component	CRM
Bronchospasm diagnosis and approach: Collect patient clinical data, observe the patient, verify airway, evaluate breathing (RR, cyanosis, wheezing). Review monitoring. Feel for pulses, verify BP, auscultate, monitor. **Treating bronchospasm:** O2, increase anaesthetic depth, nebulization with salbutamol and ipratropium bromide. Consider corticoids, aminophylline, remove all of the drugs that may remove bronchospasm. Re-evaluate. Repeat measures.	Safety Leadership Communication Coordination Teamwork Use all of the information Cognitive support Verify, confirm, re-evaluate

Narrative description of the scenario

Female, 55-year-old patient, proposed for a nephrectomy due to kidney cancer. Immediately after induction, once the anaesthesiology specialist left the OR, the patient, showed a sudden increase of respiratory pressures (peak pressures 35-42), a change in the capnography curve (which turned ascendent), a reduction of the tidal volume, peripheral desaturation and hypotension. If the team does not identify the problem, the patient progresses to a serious hypoventilation with desaturation and bradycardia with cardiac arrest due to hypoxia (non-shockable rhythm).

Team

Actors	Nurse		
Instructors	Instructor 1		
Participants	Doctor 1	Doctor 2	Doctor 3

Scenario summary: Information for all participants

Female, 55-year-old patient, proposed for a nephrectomy due to kidney cancer. Immediately after induction, once the anaesthesiology specialist left the OR, the patient, showed a sudden increase of respiratory pressures (peak pressures 35-42), a change in the capnography curve (which turned ascendant), a reduction of the tidal volume, peripheral desaturation and hypotension.

Preparing the scenario

OR scenario: Monitor, ventilator, perfusion syringe and emergency cart. Cart has emergency drugs.

Preparing the simulator

Laerdal simulator, intubated and ventilated. FiO2 40%; RR 14 cpm, O2Sat 92%. Change in the capnography curve. Peak pressure 35-42, reduction in tidal volume. Lung auscultation with diffuse wheezing BP: 90/55mmHg; HR 105 with three second capillary filling time. No surgical haemorrhage.

Simulator activity during the scenario

Laerdal simulator, intubated and ventilated. FiO2 40%, RR 14cpm, O_2Sat 92%. Change in the capnography curve. Peak pressure 35-42, reduction in tidal volume. Lung auscultation with diffuse wheezing. C: BP= 70/40 mmHg, HR 105 bpm, three second capillary filling time If they start therapeutic measures, O2Sat and BP improves. If they don't - Reduction in tidal volume - Reduction in O2Sat -> 89% -> 72%... - Bradycardia

- Arrest in a non-shockable rhythm (Hypoxia)

Debriefing planning (guided by the learning objectives and checklists)

Medical component	Group	Group	Group	Group
Systematic approach to the urgent/emergent patient				
1. ABCDE approach				
2. Identify the critical patient				
3. Ask for help				
Identify the problem				
1. Increase FiO2				
2. Airway approach – Confirm tube positioning				
3. Identify bronchospasm				
4. Increase anaesthetic depth				
5. Remove bronchospasm inducing drugs				
6. Administer bronchodilators and corticoids				
7. Other measures (aminophylline, IM adrenaline)				
In case of cardiac arrest				
1. Know the algorithm				
2. Recognise rhythms				
3. Identify causes of the arrest				
4. Correct potential causes				
Forwarding the patient				
1. Deciding where to direct the patient				
2. Describing the patient history and current state				
3. Preparing transport				
CRM				
1. Safety				
2. Leadership				

3. Communication				
4. Coordination				
5. Teamwork				
6. Use all of the information				
7. Cognitive support				
8. Verify, confirm, re-evaluate				

Plano Pedagógico Nacional
INTERNATO DE ANESTESIOLOGIA

Centro de Simulação Biomédica de Coimbra

Scenario script

Clinical case: convulsion crisis

<table>
<tr><td>Major problem</td><td>Medical component
Approach to a convulsive crisis</td><td>CRM
- Systematic approach
- Teamwork</td></tr>
<tr><td>Final objectives</td><td>Medical component
- Diagnose, evaluate the most likely aetiology and treat convulsive crisis
- Intervention during a convulsive crisis
- Options for drug treatment and criteria for hospital care</td><td>CRM
- Use all the information
- Task distribution
- Establishing priorities dynamically
- Cognitive support
- Call for help</td></tr>
<tr><td>Narrative description</td><td colspan="2">Male, 48-year-old with diabetes and hypertension. As he was observed during an appointment, he began feeling visual changes and 20 seconds later a convulsive tonic-clonic crisis begins.
Evolution according to the therapeutic measures taken.
No previous allergies. Chronically medicated with enalapril, metformin and gliclazide.</td></tr>
<tr><td>Scenario team</td><td>Operator:
Scenario director:
Instructors:
Actors:</td><td>Participants
Four doctors in training</td></tr>
<tr><td>Introduction to the scene</td><td>All the participants
Male, 48-year-old with diabetes and hypertension</td><td></td></tr>
<tr><td>Preparing the setting and environment</td><td colspan="2">At the consultation room
In the room there must be the usual emergency equipment present in a consultation room.</td></tr>
<tr><td>Scenario “life-savers”</td><td colspan="2">Facilitator in the room.</td></tr>
</table>

Scenario objectives and key points of the debriefing

Medical component	CRM
- Clinical information. - Diagnosis of a convulsive crisis. - **Performed measures:** No restriction of the tonic-clonic movements; no placement of gadgets in the oropharynx during the convulsion; administer O2; evaluate glycemia and vital signs. - Underlying cause: hypoglycaemia, low blood pressure due to a vagal reaction or in the context of bradycardia, stroke due to hypertension. - Therapeutic measures and drugs used. Reversion of the crisis. Cause. Why? - Other therapeutic measures performed. - Criteria for hospital reference: epileptic mal seizure, first episode, recurrent episodes and difficult stabilization.	- Use all the information - Task distribution - Establishing priorities dynamically - Use of cognitive support - Call for help

Narrative description of the scenario

Male, 48-year-old with diabetes and hypertension. During a scheduled appointment he began feeling visual changes and 20 seconds later a convulsive tonic-clonic crisis begins. Evolution according to the therapeutic measures taken. No previous allergies. Chronically medicated with enalapril, metformin and gliclazide.

Team

Actors	Nurse 1			
Instructors	Instructor 1			
Participants	Doctor 1	Doctor 2	Doctor 3	Doctor 4

Scenario summary: Information for all participants

Male, 48-year-old with diabetes and hypertension. During a scheduled appointment he began feeling visual changes and, 20 seconds later, a convulsive tonic-clonic crisis begins.

Preparing the scenario

Patient with a tonic-clonic generalized convulsion with loss of sphincter control. The nurse arrives at the consultation room and offers to help.

Preparing the simulator

Simulator: Patient convulsing. In the immediate postictal state, he does not respond, gasping for air and empty look. Hemodynamically stable; BP 144/82; RR 30; O2Sat 92%

Simulator activity during the scenario

Simulator: I – Initially the patient is in tonic-clonic convulsion with loss of sphincter control II – Postictal state – Hemodynamically stable. Gasping for air. (Cause: hypoglycaemia?) Glycemia 41 III – Progressive recovery of neurological state

Debriefing planning (guided by the learning objectives and checklists)

Medical component	Group	Group	Group	Group
Systematic approach to the urgent/emergent patient				
1. ABCDE approach				
2. Identify the critical patient				
3. Ask for help				
Support measures				
1. Administer oxygen				
2. No movement restriction				
3. Protect from possible movement induced lesions (pillow under head, spread objects etc.)				
Diagnosis and approach				
1. Understand that it is a convulsive crisis				
2. Choose the appropriate drugs				
3. Discuss potential causes (hypoglycaemia; stroke from hypertension; hypotension due to vagal reaction or bradycardia)				
4. Perform according to the underlying cause				
Forwarding the patient				
1. Deciding where to direct the patient				
2. Describing the patient history and current state				
3. Preparing transportation				
CRM				
1. Use all the information				
2. Task distribution				
3. Establishing priorities dynamically				
4. Use of cognitive support				
5. Call for help				

Scenario script

Clinical case: difficult airway in a burn victim

<table>
<tr><td>Major problem</td><td>Medical component
Burn after explosion, difficult airway, cervical immobilization. Possible evolution into ventricular fibrillation (VFib) needing ALS.</td><td>ACRM
- Establish leadership
- Teamwork
- Distributing tasks
- Establish priorities
- Ask for help</td></tr>
<tr><td>Final objectives</td><td>Medical component
Know the initial approach to a patient victim of an explosion burn (ABCDE)
Establish adequate treatment for the situation
Recognize and treat VFib (if needed), applying the ALS algorithm</td><td>ACRM
- Establish leadership
- Teamwork
- Distributing tasks
- Establish priorities
- Ask for help</td></tr>
<tr><td>Narrative description</td><td colspan="2">Factory worker (tire factory) victim of an explosion.
The patient is transported by an ambulance into the hospital ER. The patient is conscious, with pain. He has burns in his face, neck, torso and upper limbs. After monitoring: high BP (180/95mmHg), tachycardic (HR 135 bpm), O2Sat 92%.
He has a peripheral access.
Establish fluid protocol and start analgesia.
The patient presents with difficulty in breathing (RR 24-30cpm, O2Sat decreasing to values under 80%). There is a need for orotracheal intubation which is more difficult due to the airway oedema.
If the team takes too long or cannot intubate, the patient evolves into VFib. Apply the ALS algorithm.</td></tr>
<tr><td>Scenario team</td><td>Operator:
Scenario director:
Instructors:
Actors: nurse</td><td>Participants
Four doctors</td></tr>
<tr><td>Introduction to the scene</td><td>All of the participants
Tire factory worker victim of an explosion. Temporary loss of consciousness. Transported on an ambulance.</td><td>Key-places
Nurse</td></tr>
<tr><td>Preparing the place and environment</td><td colspan="2">Simulator lying down with burns in his face, neck, thorax and upper limbs.
Cervical brace.</td></tr>
<tr><td>Scenario “life-savers”</td><td colspan="2">Facilitating nurse that suggests the ABCDE approach if the team does not take initiative.</td></tr>
</table>

Scenario objectives and key points of the debriefing

Medical component	CRM
- Trauma ABCDE - Therapeutic measures and drugs. Why? - VFib diagnosis - Therapeutic measures taken - Transfer the patient after recovery	- Establish leadership - Distributing tasks - Establish priorities - Ask for help

Narrative description of the scenario

Factory worker (tire factory) victim of an explosion. The patient is transported by an ambulance into the hospital ER. The patient is conscious, with pain. He has burns in his face, neck, torso and upper limbs. After monitoring: high BP (180/95mmHg), tachycardic (HR 135 bpm), O2Sat 92%. He has a peripheral access. Establish fluid protocol and start analgesia. The patient presents with difficulty in breathing (RR 24-30cpm, O2Sat decreasing to values under 80%). There is a need for orotracheal intubation which is more difficult due to the airway oedema. If the team takes too long or cannot intubate, the patient evolves into VFib. Apply the ALS algorithm.

Team

Actors	Nurse			
Instructors	Instructor 1			
Participants	Doctor 1	Doctor 2	Doctor 3	Doctor 4

Scenario summary: Information for all participants

Factory worker (tire factory) victim of an explosion. The patient is transported by an ambulance into the hospital ER. The patient is conscious, with pain. He has burns in his face, neck, torso and upper limbs. After monitoring: high BP (180/95mmHg), tachycardic (HR 135 bpm), O2Sat 92%.

Preparing the scenario

ER environment Patient lying on a bed, monitored (BP, O2Sat and HR) Emergency cart ready as well as the basic airway cart. Catheters and saline at your disposal Nurse performing basic care.

Preparing the simulator

The patient is conscious, with pain. He has burns in his face, neck, torso and upper limbs. After monitoring: high BP (180/95mmHg), tachycardic (HR 135 bpm), O2Sat 92%.

Simulator activity during the scenario

The patient is conscious, with pain. He has burns in his face, neck, torso and upper limbs. After monitoring: high BP (180/95mmHg), tachycardic (HR 135 bpm), O2Sat 92%.
- Fluid therapy should be started according to the best practice in burn victims. (Another access is needed)
- Analgesia should be started.

The patient presents with difficulty in breathing (RR 24-30cpm, O2Sat decreasing to values under 80%). There is a need for orotracheal intubation which is more difficult due to the airway oedema.

If the team takes too long or cannot intubate, the patient evolves into VFib. Apply the ALS algorithm.

After stabilizing, prepare the patient transfer into a Burn Unit.

Debriefing planning (guided by the learning objectives and checklists)

Medical component	Group	Group	Group	Group
Systematic approach to the urgent/emergent patient				
1. ABCDE approach				
2. Identify the critical patient				
3. Ask for help				
Support measures				
1. Administer O2				
2. Airway approach (trace a plan and why – think of it as a difficult airway)				
3. Peripheral access and fluids according to the burn area				
4. Analgesia				
In case of cardiac arrest				
1. Know the algorithm				
2. Recognise rhythms in the EKG				
3. Identify causes of the arrest				
4. Correct potential causes				
Forwarding the patient				
1. Deciding where to direct the patient – Burn Unit				
2. Describing the patient history and current state				
3. Preparing transport				
CRM				
1. Establish leadership				
2. Distributing tasks				
3. Establish priorities				
4. Ask for help				

Plano Pedagógico Nacional
INTERNATO DE ANESTESIOLOGIA

Centro de
Simulação Biomédica
de Coimbra

Scenario script

Clinical case: difficult airway – facial trauma

<table>
<tr><td>Major problem</td><td>Medical component
Approach to a difficult airway</td><td>CRM
- Systematic approach
- Teamwork</td></tr>
<tr><td>Final objectives</td><td>Medical component
Approach to the airway of a patient with facial trauma after a motorcycle accident:
- Difficult airway algorithm
- Invasive airway vs. not invasive airway</td><td>ACRM
- Safe and efficient approach
- Leadership
- Communication
- Distribution of tasks
- Repeated revaluation</td></tr>
<tr><td>Narrative description</td><td colspan="2">Male patient, 38 years old, suffered a motorcycle accident. No previous diseases. He arrived at the Emergency Room. Facial trauma (he was using a helmet but no visor), a neck brace was placed, several lesions on the torso and lower limbs were present. The nurse calls for the support team.</td></tr>
<tr><td>Scenario team</td><td>Operator:
Scenario director:
Instructors:
Actors:</td><td>Participants
Four Doctors</td></tr>
<tr><td>Introduction to the scene</td><td>All the participants
The support team was called to the Emergency Room to approach a patient that had just arrived, brought by the fireman corporation on an ambulance.</td><td>“Key places”</td></tr>
<tr><td>Preparing the setting and environment</td><td colspan="2">Environment in the Emergency Room.
No peripheral access with bandages on his face with abundant bleeding simulating severe trauma (bruising). Abrasions on the torso. Lower limbs with bandages with blood simulating a fracture. Neck brace.</td></tr>
<tr><td>Scenario “life-savers”</td><td colspan="2">Facilitating nurse that suggests the ABCDE approach if the team does not take initiative.</td></tr>
</table>

Scenario objectives and key points of the debriefing

Medical component	CRM
Evaluate the facial trauma Foresee the difficulties in approaching the airway. Establish an algorithm to approach the airway (initial invasive or not invasive approach, approach with the patient awake or under anaesthesia, supraglottic vs translaryngeal approach, etc)	Leadership Communication Using all the information Cognitive support Verify, confirm and re-evaluate

Narrative description of the scenario

Male patient, 38 years old, suffered a motorcycle accident. No previous diseases. He is in the Emergency Room after being transported by the fireman department on a not medicalized ambulance. He shows facial trauma (he was using a helmet but no visor), with a neck brace placed, several bruises on the torso and fracture of the lower limb. Strong suggestion of cervical trauma from the description of the accident.
The nurse requests the present of the support team to the Emergency Room.

Team

Actors	Nurse			
Instructors	Instructor 1			
Participants	Doctor 1	Doctor 2	Doctor 3	Doctor 4

Scenario summary: Information for all participants

Male patient, 38 years old, suffered a motorcycle accident. No previous diseases. He is in the Emergency Room after being transported by the fireman department on a not medicalized ambulance.

Preparing the scenario

Patient in the Emergency Room. He shows facial trauma (he was using a helmet but no visor), with a neck brace placed, several bruises on the torso and fracture of the lower limb. Strong suggestion of cervical trauma from the description of the accident.

Preparing the simulator

Simulator:
Facial trauma has a neck brace, bruises in his torso and fracture of his lower limb. He has an audible gurgle, inability to open the airway, limited cervical mobilization due to the cervical brace and apparent cervical trauma.
Polypneic with superficial breathing and cough. RR 28; O2Sat 90%; Very anxious, HR 105; BP 100/42.

Simulator activity during the scenario

A - Audible gurgle, inability to open the airway, limited cervical mobilization due to the cervical brace and apparent cervical trauma.

B - Polypneic with superficial breathing and cough. RR 28; O2Sat 90%.

C - Very anxious, HR 105; BP 100/42 mmHg.

What is expected:

- Oxygen administration (high flow mask);
- Airway approach (invasive or not, awaken or after induction);
- Peripheral access for fluids and drugs.

If the team doesn't act adequately, the simulator will show progressive desaturation with worsening tachycardia and hypotension. Then enters cardiorespiratory failure (V Fib).

ALS algorithm, identifying the causes for the arrest. (Hypoxia and hypovolemia).

Debriefing planning (guided by the learning objectives and checklists)

Medical component	Group	Group	Group	Group
Systematic approach to the urgent/emergent patient				
1. ABCDE approach				
2. Identify the critical patient				
3. Ask for help				
Support measures				
1. Administer oxygen using a high flow mask				
2. Airway approach (trace a plan and why)				
3. Peripheral access and fluids				
4. Perform all the actions considering there might be a cervical fracture				
In case of cardiac arrest				
1. Know the algorithm				
2. Identify causes of the arrest				
3. Correct potential causes				
Forwarding the patient				
1. Deciding where to direct the patient				
2. Describing the patient history and current state				
3. Preparing transportation				
CRM				
1. Leadership				
2. Communication				
3. Using all the information				
4. Cognitive support				
5. Verify, confirm and re-evaluate				

Plano Pedagógico Nacional
INTERNATO DE ANESTESIOLOGIA

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Scenario script

Clinical case: difficult airway on an emergent caesarean section

Major problem	**Medical component** Difficult airway + emergent caesarean section + revive a newborn	**ACRM** Airway algorithm Advanced life support algorithm of the newborn
Final objective	**Medical component** Cannot ventilate, cannot intubate Following the algorithm	**ACRM** Ask for help Communicate Leadership Distribute tasks
Narrative description	Emergent caesarean section on a pregnant woman in the OR, ready for surgery. Obstetrician sterilized and awaiting the arrival of the anaesthetic team.	
Scenario team	**Operator:** **Scenario director:** **Instructors:** **Actors:** nurse	**Participants** Anaesthesiologist and senior paediatrician Two interns
Introduction to the scene	**All of the participants** Anaesthesiologist, a senior paediatrician and two interns distributed according to the group	**"Key places"** Senior anaesthesiologist
Preparing the place and environment	Simulator with pregnancy pillow, surgical fields, peripheral venous access, baby monitorization. Already prepared drugs: Thiopental, succinylcholine, fentanyl, atropine and non-depolarizing muscular relaxants. Support material: ETT, LMA, LMA Proseal, LMA Supreme, I-Gel, Combitube, Laringeal tubes, Fastrach, Serum, systems, needles, venous catheter and available syringe.	
Scenario "life-savers"	Facilitating nurse that suggests using LMA if the team does not follow the algorithm until its use.	

Scenario objectives and key points of the debriefing

Medical component	CRM
Difficult airway algorithm Algorithm to revive a newborn	Ask for help Communicate Leadership Distribute tasks

Narrative description of the scenario

Pregnant patient, 1st gestation, placed in the OR for an emergent caesarean section with the obstetrician ready to begin the surgery. Nurse calls for the Anaesthesiologist and Paediatrician.

Team

Actors	Surgeon 1	Surgeon 2	Nurse 1	
Instructors	Instructor 1	Instructor 2		
Participants	Anaesthesiologist	Anaesthesia Intern	Paediatrician	Paediatrics intern

Scenario summary: Information for all participants

Pregnant patient, 1st gestation, placed in the OR for an emergent caesarean section with the obstetrician ready to begin the surgery. Nurse calls for the Anaesthesiologist and Paediatrician. The Obstetrician informs the senior Anaesthesiologist that the patient is a healthy pregnant woman that requires an emergent caesarean section due to foetal suffering. She has just arrived at the ER as the foetus is bradycardic. The nurse says: “What do you need doctor”?

Preparing the scenario

1. Pregnant patient on the OR table with surgical drapes, monitored (BP 145/85 mmHg, HR 110bpm; O2Sat 98%).
Large volume of clothes simulating the newborn on the surgical table.
Support material: ETT (6.5, 7,7.5,8,8.5), guedel green and orange, Facial mask 3,4,5.
Emergency car available.

2. Newborn, covered and ready to be monitored and resurrected.

Paediatric material.
Face mask, Tubes 2.5,3,3.5.
Paediatric laryngoscope.
Aspirating catheter.
Paediatric AMBU.
Oximetry, BP sleeve, monitoring material.

Clinical process with information. A healthy pregnant woman, 32 years old, 75kg, 160cm high.
No prior medical/surgical diseases. No allergies. No chronic medication.
Six hour fasting period for solids and three hours for liquids.

Obstetric history – 36W foetus, cephalic position.

No complications so far. The foetus is now bradycardic, and the patient has just arrived at the ER as she has entered labour. The foetus requires emergent caesarean section.

Cause for intervention - emergent caesarean section due to acute foetal suffering.

Preparing the simulator

Pregnant in spontaneous breathing, after a quick induction therapy, triggered trismus and laryngospasm. Peripheral cyanosis, progressive decrease in peripheral oxygen saturation, bradycardia and hypotension.

Baby monitoring: HR 80bpm; hypotonic, cyanotic, bradypnea.

Simulator activity during the scenario

Pregnant in spontaneous breathing, after a quick induction therapy, triggered trismus and laryngospasm. Peripheral cyanosis, progressive decrease in peripheral oxygen saturation, bradycardia and hypotension.

Baby monitoring: HR 80bpm; hypotonic, cyanotic, bradypnea.

Debriefing planning (guided by the learning objectives and checklists)

Medical component	Group	Group	Group	Group
Following the difficult airway algorithm – Impossible initial intubation (ASA)				
1. Ask for help				
2. Return to spontaneous ventilation				
3. Wake the patient up				
Support measures				
1. O2 100%				
2. Articulated laryngoscopy A. Mandrill tube				
3. Videolaryngoscope				
Ineffective ventilation with a mask - alternatives				
1. Return to spontaneous ventilation				
2. LMA/laryngeal tube a. Alternative LMA				
3. Invasive approach to the airway				
Following the newborn advanced life support algorithm				
1. Monitoring				
2. ABCDE approach				
CRM				
1. Ask for help				
2. Communicate				
3. Leadership				
4. Distribute tasks				

Scenario script

Clinical case: DNR

Major problem	**Medical component** Cardiac arrest in a terminally ill patient on the gynaecology ward with the decision not to attempt resuscitation	**ACRM** - Leadership - Distribute tasks - Unknown environment - Use all of the information
Final objectives	**Medical component** - Approach to the patient (O2, monitor, peripheral access, emergency cart) - Basic life support (stimulate the patient, ask for help, airway; A; B; C, compressions 30: two for two minutes. Adrenaline every three-five minutes (alternate cycles) - Correct reversible causes - Decide not to initiate/stop resuscitation	
Narrative description	65-year-old female patient with a previous stroke with motor sequelae which made her dependent in basic daily activities, COPD, epilepsy and depression. Submitted to a radical mastectomy in 2010 due to an invasive G2 ductal carcinoma. Now she has liver and lung metastization. Chronically medicated with carbamazepine, trimipramine, diazepam, omeprazole sucralfate, furosemide, tramadol and montelukast. She was admitted at the emergency department due to worsening of her clinical state and anorexia. Blood tests showed an increase in inflammatory parameters. Palliative care was already programmed. Nasogastric cannulation was already needed for drug administration and feeding. The team is called to the ward by the nurse. The patient has her eyes closed, is tachypnoeic, with loud and uncoordinated respiration with an O2Sat of 90%. She was also hypotensive.	
Scenario team	**Operator:** **Scenario director:** **Instructors:** **Actors:** son of the patient; responsible doctor; Nurse	**Participants** Four doctors
Introduction to the scene	**All of the participants** The same narrative	

Preparing the place and environment	The scenario takes place in the ward. The simulator is dressed in a shirt, a nasogastric tube with O2 through nasal prongs. She is sweating profusely with eyes closed, tachypnoeic with loud and uncoordinated respiration. Peripheral saturation of 90%. Hypotense. The patient file is present with all the information.
Scenario “life-savers”	Responsible doctor must insist that although there is nothing in the patient file, that in a reunion there was a “do not resuscitate” decision. Nurse: Has just arrived and no one told her that although it seems possible from the patient’s prior diseases. Does not assume the responsibility of that information. Son: Repeatedly asks to save his mother. “she is a fighter” she would want to live… No one told him that she had a do not resuscitate decision

Scenario objectives and key points of the debriefing

Medical component	CRM
- Cardiac arrest diagnosis - Evaluating the clinical history - Decision not to resuscitate (theoretically)	Safety Leadership Communication Coordination Teamwork Use all of the information Verify, confirm, re-evaluate

Narrative description of the scenario

Patient with a metastized breast cancer admitted at the ward that feels breathless and sweats profusely, progressively becoming worse. The medical team was called to evaluate the patient as she deteriorates and enters cardiac arrest.

Team

Actors	Patient's son	Nurse	Doctor responsible	
Instructors	Instructor 1			
Participants	Doctor 1	Doctor 2	Doctor 3	Doctor 4

Scenario summary: Information for all participants

65-year-old female patient with a previous stroke with motor sequelae which made her dependent in basic daily activities, COPD, epilepsy and depression. Submitted to a radical mastectomy in 2010 due to an invasive G2 ductal carcinoma. Now she has liver and lung metastization. Chronically medicated with carbamazepine, trimipramine, diazepam, omeprazole sucralfate, furosemide, tramadol and montelukast.

She was admitted at the emergency department due to worsening of her clinical state and anorexia. Blood tests showed an increase in inflammatory parameters. Palliative care had been already programmed. Nasogastric cannulation was already needed for drug administration and feeding.

The team is called to the ward by the nurse. The patient has her eyes closed, is tachypnoeic, with loud and uncoordinated respiration with an O2Sat of 90%. She was also hypotense.

Preparing the scenario

The scenario takes place in the ward.

The bed is at a 30º inclination.

Preparing the Simulator

Noelle simulator, dressed in a night gown. Nasogastric tube. Eyes closed, loud breathing.

Simulator activity during the scenario

The scenario takes place in the ward The simulator is dressed in a gown, a nasogastric tube with O_2 through nasal prongs. She is sweating profusely with eyes closed, tachypnoeic with loud and uncoordinated respiration. Peripheral saturation of 90%. Hypotense. Temperature is 35.6ºC. O2Sat is decreasing. Pre-arrest scenario. If intubated, return to a sinus rhythm with an increase in O2Sat -> Moment to forward the patient and decide the therapeutic plan.

Debriefing planning (guided by the learning objectives and checklists)

Medical component	Group	Group	Group	Group
Systematic approach to the critical patient				
1. ABCDE approach				
2. Identify the critical patient				
3. Ask for help				
Support measures				
1. Administer O2				
2. Check the file				
3. Discuss the case with the doctors that know the patient				
4. Decide the limit				
DNR decision				
1. Adequate dialogue with the team – without causing discomfort				
2. Talk with the patient's son				
CRM				
1. Safety				
2. Leadership				
3. Communication				
4. Coordination				
5. Teamwork				
6. Use all of the information				
7. Verify, confirm, re-evaluate				

Scenario script

Clinical case: dysrhythmia

Major problem	**Medical component** Approach to the critical patient in the pre-hospital care.	**CRM** - Safety - Systematic approach - Teamwork
Final objectives	**Medical component** - Show competence in leading a pre-hospital care team - Diagnose and treat a critical condition/dysrhythmia - Collect information - O2 and monitor patient - Treat the patient	**CRM** - Safe - Leadership - Communication - Coordinate actions in the team
Narrative description	68-year-old male patient living in São João do Campo – Coimbra. As prior diseases he recalls hypertension, a benign prostate disease and a “cardiac disease”. Chronically medicated with furosemide, hydrochlorothiazide, captopril and digoxin. Smoker for 10 years. Drinks alcohol regularly. After arriving home, he feels a generalized indisposition, palpitations and pain in his sternum. Asks his wife to call 112 quickly.	
Scenario team	**Operator –** **Scene director –** **Instructors –** instructor 1 + instructor 2 **Actors** – wife/neighbour	**Participants** One doctor One nurse One emergency technician
Introduction to the scene	**All of the participants** CODU central warns the emergency team of the occurrence and the address.	**«Key places»** CODU doctor that accompanies the occurrence and the intervention of the pre-hospital care.
Preparing the place and environment	The scene takes place at the patient’s house. The patient is lying on the bed in his room, pale, conscious just muttering words. Has his hands on his chest.	
Scenario “life-savers”	If the team does not check the place for safety conditions the wife says that she will turn the gas off in the kitchen and will be right back. If the team does not present themselves to the wife, she will ask who they are and what are they doing. If they don’t diagnose dysrhythmia the wife will say that her husband has an “arrhythmia” If they don’t prepare to defibrillate in I, the scene evolves into II.	

	If the patient is not stable, CODU communicates asking if the patient is stable for transport as well as more information and if they need to contact the hospital.

Scenario objectives and key points of the debriefing

Medical component	CRM
Moving to the place: safely, collecting more information and planning the approach Diagnosis and approach to dysrhythmia: verify safety, talk to the patient, collect data from the patient and wife, observe the patient, palpate, auscultate, monitor. Treat dysrhythmia: O2, peripheral access, medication, defib, others Transport: Planning, information to CODU and to the hospital, safety	Safety Leadership Communication Coordination Teamwork Use all of the information Cognitive support Verify, confirm, re-evaluate

Narrative description of the scenario

68-year-old male patient living in São João do Campo – Coimbra. As prior diseases he recalls hypertension, a benign prostate disease and a "cardiac disease". Chronically medicated with furosemide, hydrochlorothiazide, captopril and digoxin. Smoker for 10 years. Drinks alcohol regularly. After arriving home, he feels a generalized indisposition, palpitations and pain in his chest. Asks his wife to call 112 quickly. Initially the patient's HR is at 160bpm; BP 78/30mmHg; RR 14 cpm; O2Sat90%. Normal lung auscultation. Tachycardia on the cardiac auscultation. Pale, mutters words and moves the area around the chest area. Evolves into afasia and stops muttering. HR 180; BP 68/30; RR 10. Worsens with loss of consciousness, desaturation and pulseless.

Team

Actors	Wife	Neighbour		
Instructors	Instructor 1			
Participants	Doctor 1	Doctor 2	Doctor 3	Doctor 4

Scenario summary: Information for all participants

Patient who arrives at his home telling his wife he has generalized indisposition, palpitations and pain in his chest. His clinical state worsens with the arrival of the emergency team, terminating in a loss of consciousness

Preparing the scenario

Common house with his wife and his neighbour. Boxes of prescription medication by the patient's bed as well as blood tests and an EKG. He's on the bed, pale, muttering words, with his hand on the chest.
The neighbour reinforces that he has a high blood pressure and a cardiac disease

Preparing the simulator

Initially the patient's HR is at 160bpm; BP 78/30mmHg; RR 14 cpm; O2Sat90%. Normal lung auscultation. Tachycardia on the cardiac auscultation. Pale, mutters words and moves the area around the chest area.

Evolves into aphasia and stops muttering. HR 180; BP 68/30; RR 10;

Worsens with loss of consciousness, desaturation and pulseless.

Simulator activity during the scenario

I - Initially the patient's HR is at 160bpm; BP 78/30mmHg; RR 14 cpm; O2Sat90%. Normal lung auscultation. Tachycardia on the cardiac auscultation. Pale, mutters words and moves the area around the chest area. EKG: VT with pulse. When the team gets ready to defib evolves into II. II - Evolves into aphasia and stops muttering. HR 180; BP 68/30; RR 10; mydriatic pupils. Oximetry starts to fail. Evolves into... III - Worsens with loss of consciousness, desaturation and pulseless. Apnoea. V Fib. IV - 1st shock is ineffective; 2nd shock is effective although he presents with a total AV block for two minutes. Recovers consciousness; HR 37bpm; BP 85/40mmHg; O2Sat 92%. Na external pacemaker should be placed. V - Clinical situation stabilizes HR 54; BP 108/60; O2Sat 96%. Transported to the hospital after transport planning and information to CODU soliciting a warning to de ER.

Debriefing planning (guided by the learning objectives and checklists)

Medical component	Group	Group	Group	Group
Systematic approach to the urgent/emergent patient				
1. ABCDE approach				
2. Identify the critical patient				
3. Ask for help				
Diagnosis				
1. Identify the importance of quick monitoring				
2. Identify the initial rhythm in the monitorization				
3. Establishing a treatment plan				
4. O2 using a mask				
5. Identify the need for external pacing				
In case of cardiac arrest				
1. Know the algorithm				
2. Recognise the rhythms				
3. Identify causes of the arrest				
4. Correct potential causes				
Forwarding the patient				
1. Deciding where to direct the patient				
2. Describing the patient history and current state				
3. Preparing transport				
CRM				
1. Safety				
2. Leadership				
3. Communication				
4. Coordination				
5. Teamwork				
6. Use all of the information				
7. Cognitive support				
8. Verify, confirm, re-evaluate				

Scenario script

Clinical case: factory explosion

<table>
<tr><td>Major problem</td><td>Medical component
Explosion burn, difficult airway, possible evolution to ventricular fibrillation (Vfib)</td><td>ACRM
- Establish leadership
- Teamwork
- Distributing tasks
- Establish priorities
- Ask for help</td></tr>
<tr><td>Final objectives</td><td>Medical component
Know the initial approach to a patient victim of an explosion burn (ABCDE).
Establish adequate treatment for the situation.
Recognize and treat VFib (if needed), applying the ALS algorithm.
Taking care of patient evacuation.
Anticipate the arrival of more victims.</td><td>ACRM
- Establish leadership
- Teamwork
- Distributing tasks
- Establish priorities
- Ask for help</td></tr>
<tr><td>Narrative description</td><td colspan="2">Factory worker (tire factory) victim of an explosion.
Work colleagues didn’t wait for the medical team and brought the patient to the local Physician. The patient is conscious, with pain. He has burns in his face, neck, torso and upper limbs. After monitoring: high BP (180/95mmHg), tachycardic (HR 135 bpm), O2Sat 92%.
A peripheral access should be found and fluid therapy should be started according to the best practice in burn victims.
Analgesia.
The patient presents with difficulty in breathing (RR 24-30cpm, O2Sat decreasing to values under 80%). There is a need for orotracheal intubation which is more difficult due to the airway oedema.
If the team takes too long or cannot intubate, the patient evolves into VFib. Apply the ALS algorithm. After stabilizing the patient, they must deal with his transfer to a hospital with a Burn Unit (call CODU).</td></tr>
<tr><td>Scenario team</td><td>Operator:
Scenario director:
Instructors:
Actors: facilitating doctor/ nurse</td><td>Participants
Four doctors</td></tr>
<tr><td>Introduction to the scene</td><td>All of the participants
Tire factory worker victim of an explosion</td><td>Key-places
Physician
Nurse (One or Two)</td></tr>
</table>

Preparing the place and environment	Simulator lying down with burns in his face, neck, thorax and upper limbs. In the room there is a colleague that gives information and then leaves. Room of a primary health care centre. Telephone.
Scenario "life-savers"	Facilitating doctor that suggests the ABCDE approach if the team does not take initiative. Nurse thinks of the patient transfer if no initiative has been taken by the team.

Scenario objectives and key points of the debriefing

Medical component	CRM
Trauma ABCDE Therapeutic measures and drugs. Why? VFib diagnosis Therapeutic measures taken Programming patient transfer	Establish leadership Teamwork Distributing tasks Establish priorities Ask for help

Narrative description of the scenario

Factory worker (tire factory) victim of an explosion.
Work colleagues didn't wait for the medical team and brought the patient to the local Physician. The patient is conscious, with pain. He has burns in his face, neck, torso and upper limbs. After monitoring: high BP (180/95mmHg), tachycardic (HR 135 bpm), O2Sat 92%.
A peripheral access should be found and fluid therapy should be started according to the best practice in burn victims.
Analgesia.
The patient presents with difficulty in breathing (RR 24-30cpm, O2Sat decreasing to values under 80%).
There is a need for orotracheal intubation which is more difficult due to the airway oedema.
If the team takes too long or cannot intubate, the patient evolves into VFib. Apply the ALS algorithm. After stabilizing the patient they must deal with his transfer to a hospital with a Burn Unit (call CODU).

Team

Actors	Doctor	Nurse		
Instructors	Instructor 1			
Participants	Doctor 1	Doctor 2	Doctor 3	Doctor 4

Scenario summary: Information for all participants

Factory worker (tire factory) victim of an explosion.
Work colleagues didn’t wait for the medical team and brought the patient to the local Physician. The patient is conscious, with pain. He has burns in his face, neck, torso and upper limbs.
He has some trouble breathing.

Preparing the scenario

Primary healthcare centre environment.
Patient lying on a bed, monitored (BP, O2Sat and HR)
Emergency cart ready as well as the basic airway cart
Catheters and saline at your disposal
Doctor and nurses at the centre performing the initial patient care (not ready to receive these victims)

Preparing the simulator

The patient is conscious, with pain. He has burns in his face, neck, torso and upper limbs. After monitoring: high BP (180/95mmHg), tachycardic (HR 135 bpm), O2Sat 92%.

Simulator activity during the scenario

The patient is conscious, with pain. He has burns in his face, neck, torso and upper limbs. After monitoring: high BP (180/95mmHg), tachycardic (HR 135 bpm), O2Sat 92%. - A peripheral access should be found and fluid therapy should be started according to the best practice in burn victims. - Analgesia should be started. The patient presents with difficulty in breathing (RR 24-30cpm, O2Sat decreasing to values under 80%). There is a need for orotracheal intubation which is more difficult due to the airway oedema. If the team takes too long or cannot intubate, the patient evolves into VFib. Apply the ALS algorithm. After stabilizing the patient, they must deal with his transfer to a hospital with a Burn Unit (call CODU).

Debriefing planning (guided by the learning objectives and checklists)

Medical component	**Group**	**Group**	**Group**	**Group**
Systematic approach to the urgent/emergent patient				
1. ABCDE approach				
2. Identify the critical patient				
3. Ask for help				
Support measures				
1. Administer O2				
2. Airway approach (trace a plan and why – think of it as a difficult airway)				
3. Peripheral access and fluids according to the burn area				
4. Analgesia				
In case of cardiac arrest				
1. Know the algorithm				
2. Recognise rhythms in the EKG				
3. Identify causes of the arrest				
4. Correct potential causes				
Forwarding the patient				
1. Deciding where to direct the patient – Burn Unit				
2. Describing the patient history and current state				
3. Preparing transport				
CRM				
1. Establish leadership				
2. Teamwork				
3. Distributing tasks				
4. Establish priorities				
5. Ask for help				

Scenario script

Clinical case: residual curarization in the post-operative period

<table>
<tr><td>Major problem</td><td>Medical component
Residual curarization on the post-operative period.</td><td>ACRM
- Establish leadership
- Teamwork
- Distributing tasks
- Unaware of the environment</td></tr>
<tr><td>Final objectives</td><td>Medical component
Know how to diagnose and treat residual curarization on the post-operative period</td><td>ACRM
- Establish leadership
- Use all of the information
- Distributing tasks
- Unaware of the environment</td></tr>
<tr><td>Narrative description</td><td colspan="2">60-year-old male patient. ASA II. Diabetic controlled with medication and obese (BMI 32, weight 95kg).
Submitted to an elective laparoscopic cholecystectomy. Premedicated with 7.5mg of oral midazolam, 50mg of IV ranitidine and 10mg of IV metoclopramide.
Anaesthetic induction performed with fentanyl, propofol and rocuronium (1mg/kg) and maintenance with sevoflurane and fentanyl once again. No more muscle relaxant was administered. Surgery underwent for 45 minutes. One g of paracetamol and 200mg of tramadol diluted in 100ml of saline.
The patient was not decurarized since rocuronium had been administered 70 min ago. He was extubated and transported to the post anaesthetic ward where he has been for the past 10 minutes.
You were called to the ward by the nurse since the anaesthesiologist had to leave the ward
The patient is sweating, eyes closed, tachypnoeic, with superficial and uncoordinated breathing, O2Sat 90%, tachycardia (120 bpm) and hypertense (170/95mmHg).
Cutaneous temperature 35.6ºC.
If they want an evaluation of the TOF ratio – 0.7. Consider the possibility to perform a blood gas test.</td></tr>
<tr><td>Scenario team</td><td>Operator:
Scenario director:
Instructors:
Actors: Anaesthesia nurse</td><td>Participants
Four doctors</td></tr>
<tr><td>Introduction to the scene</td><td>All of the participants
The same narrative.</td><td>“Key places”
The nurse working at the ward (facilitator)</td></tr>
</table>

Preparing the place and environment	The scenario occurs at the post anaesthetic ward. The simulator is dressed in a shirt, with a peripheral access and O2 through a nasal cannula. Monitored with a two derivation EKG, O2Sat, non-invasive arterial pressure and cutaneous temperature. Muscular relaxation monitoring is available but should only be supplied if asked by the team. Next to the monitor is the patient file and anaesthesia file. The patient is sweating, eyes closed, tachypnoeic, with superficial and uncoordinated breathing, O2Sat 90%, tachycardia (120 bpm) and hypertense (170/95mmHg). Cutaneous temperature 35.6ºC. In the room, emergency drugs and antagonists of muscular relaxation must be present. Venous access material, analgesia, heating system must be present. There should also be a manual insufflator, face mask and connection to the O2 source, intubation material and blood tests already collected (venous and arterial). The nurse is dressed as in the ward.
Scenario "life-savers"	Anaesthesia nurse (actor)

Scenario objectives and key points of the debriefing

Medical component	CRM
Diagnosis and incidence of residual curarization in post anaesthetic wards Implications of residual curarization Differential diagnosis Therapeutic measures instituted	Leadership Distribute tasks Unaware of the environment Use all of the information Antecipate and plan

Narrative description of the scenario

60-year-old male patient. ASA II. Diabetic controlled with medication and obese (BMI 32, weight 95kg). Submitted to an elective laparoscopic cholecystectomy. Premedicated with 7.5mg of oral midazolam, 50mg of IV ranitidine and 10mg of IV metoclopramide. Anaesthetic induction performed with fentanyl, propofol and rocuronium (1mg/kg) and maintenance with sevoflurane and fentanyl once again. No more muscle relaxant was administered. Surgery underwent for 45 minutes. One g of paracetamol and 200mg of tramadol diluted in 100ml of saline.

The patient was not decurarized since rocuronium had been administered 70 min ago. He was extubated and transported to the post anaesthetic ward where he has been for the past 10 minutes.

Team

Actors	Nurse			
Instructors	Instructor 1			
Participants	Doctor 1	Doctor 2	Doctor 3	Doctor 4

Scenario summary: Information for all participants

60-year-old male patient. ASA II. Diabetic controlled with medication and obese (BMI 32, weight 95kg). Submitted to an elective laparoscopic cholecystectomy under general anaesthesia. The anaesthesia team is called by the post anaesthetic ward nurse due to worsening in patient ventilation.

Preparing the scenario

The scenario occurs at the post anaesthetic ward. The simulator is dressed in a shirt, with a peripheral access and O2 through a nasal cannula. Monitored with a two derivation EKG, O2Sat, non-invasive arterial pressure and cutaneous temperature. Muscular relaxation monitoring is available but should only be supplied if asked by the team. Next to the monitor is the patient file and anaesthesia file. The patient is sweating, eyes closed, tachypnoeic, with superficial and uncoordinated breathing, O2Sat 90%, tachycardia (120 bpm) and hypertense (170/95mmHg). Cutaneous temperature 35.6ºC. In the room, emergency drugs and antagonists of muscular relaxation must be present. Venous access material, analgesia, heating system must be present. There should also be a manual insufflator, face mask and connection to the O2 source, intubation material and blood tests already collected (venous and arterial). The nurse is dressed as in the ward.

Preparing the simulator

The simulator is dressed in a shirt, with a peripheral access and O2 through a nasal cannula. Monitored with a two derivation EKG, O2Sat, non-invasive arterial pressure and cutaneous temperature. Muscular relaxation monitoring is available but should only be supplied if asked by the team. Next to the monitor is the patient file and anaesthesia file. The patient is sweating, eyes closed, tachypnoeic, with superficial and uncoordinated breathing, O2Sat 90%, tachycardia (120 bpm) and hypertense (170/95mmHg). Cutaneous temperature 35.6ºC. In the room, emergency drugs and antagonists of muscular relaxation must be present. Venous access material, analgesia, heating system must be present. There should also be a manual insufflator, face mask and connection to the O2 source, intubation material and blood tests already collected (venous and arterial).

Simulator activity during the scenario

The patient is sweating, eyes closed, tachypnoeic, with superficial and uncoordinated breathing, O2Sat 90%, tachycardia (120 bpm) and hypertense (170/95mmHg). Cutaneous temperature 35.6ºC. If the cause is not identified and the NMB is not reverted: - Progressive worsening of O2 Sat - Need for manual ventilation and decision for orotracheal intubation

Debriefing planning (guided by the learning objectives and checklists)

Medical component	**Group**	**Group**	**Group**	**Group**
Systematic approach to the urgent/emergent patient				
1. ABCDE approach				
2. Identify the critical patient				
3. Ask for help				
Adequate treatment				
1. Administer oxygen				
2. Identify the problem				
3. Monitor NMB				
3. Using NMB reversers				
4. Airway approach if necessary				
Forwarding the patient				
1. Deciding where to direct the patient				
2. Describing the patient history and current state				
CRM				
1. Leadership				
2. Distribute tasks				
3. Unaware of the environment				
4. Use all of the information				
5. Anticipate				

Scenario script

Clinical case: trauma victim with hypovolemia and vertebro-medular trauma

<table>
<tr><td>Final objective</td><td>Medical component
ABCDE approach of the trauma victim, establish priorities, team approach, hypovolemia and VMT.</td><td>CRM
Communication
Leadership
Distribute tasks
Safe and efficient approach
Repeated re-evaluation</td></tr>
<tr><td>Narrative description</td><td colspan="2">A 28-year-old male patient has just arrived to the ER, brought by the firemen, victim of an accident after trying to dive at the beach. He hit his head on the sand and was unable to move since then. He comes immobilized with a neck brace and has plenty of blood flowing from the bandage as well as a low O2 debit face mask. Upon arrival he is conscious and does not move his four limbs. Quick and superficial breaths using accessory muscles. If they don't think of VMT with ventilatory compromise, Glasgow scale progressively worsens.</td></tr>
<tr><td>Scenario team</td><td>Operator:
Scenario director:
Instructors:
Actors: Nurse</td><td>Participants
Three anaesthesiologists</td></tr>
<tr><td>Introduction to the scene</td><td>All of the participants
The team working in the Hospital ER</td><td></td></tr>
<tr><td>Preparing the place and environment</td><td colspan="2">Monitor, ventilator, perfusion syringe and emergency cart.
Necessary material: High flow mask, orotracheal tube, LM, laryngeal tube, material for a difficult intubation</td></tr>
<tr><td>Scenario "life-savers"</td><td colspan="2">Nurse emphasizes for the desaturation trying to force changing the mask for a high flow mask. The nurse points out the bleeding and the pelvic instability trying to force the participants to distribute tasks. If they don't act the nurse suggests intubation.</td></tr>
</table>

Scenario objectives and key points of the debriefing

Medical component	CRM
ABCDE approach Establishing priorities Approach the patient as a team Approach to hypovolemia and VMT	Leadership Communication Using all of the information Cognitive support Verify, confirm and re-evaluate

Narrative description of the scenario

A 28-year-old male patient has just arrived to the ER, brought by the firemen, victim of an accident after trying to dive at the beach. He hit his head on the sand and was unable to move since then. He comes immobilized with a neck brace and has plenty of blood flowing from the bandage as well as a low O2 debit face mask. Upon arrival he is conscious and does not move his four limbs. Quick and superficial breaths using accessory muscles. If they don't think of VMT with ventilatory compromise, Glasgow scale progressively worsens.

Team

Actors	Nurse		
Instructors	Instructor 1		
Participants	Doctor 1	Doctor 2	Doctor 3

Scenario summary: Information for all participants

A 28-year-old male patient has just arrived to the ER, brought by the firemen, victim of an accident after trying to dive at the beach. He hit his head on the sand and was unable to move since then. He comes immobilized with a neck brace and has plenty of blood flowing from the bandage as well as a low O2 debit face mask. Upon arrival he is conscious and does not move his four limbs. Quick and superficial breaths using accessory muscles.

Preparing the scenario

ER scenario. Laerdal simulator with a neck brace. No peripheral access and no monitorization. Airway cart is available. Emergency cart and drugs are available. There are several types of saline, perfusion systems and perfusion pumps.

Preparing the simulator

Laerdal simulator with a neck brace. No peripheral access and no monitorization. Injury in his frontal region. Bandage on his limb with profuse haemorrhage. Conscious and without pain. RR 22, O2Sat 92%. Breathing with accessory muscles and using the diaphragm, cannot cough effectively. BP 70/40mmHg; HR 50bpm; Capillary filling time of five seconds, weak pulse, pale skin, humid and cold.

Simulator activity during the scenario

A: Conscious, without pain with a patent airway. B: RR 22cpm; O2Sat92%; Breathing using accessory muscles and his diaphragm, cannot cough effectively -> A high flow mask should be placed with a FiO2 100%. C: BP 70/40mmHg; HR 55bpm; capillary filling time of five sec, shallow pulse, pale, humid and cold skin -> He should have two peripheral accesses with good calibre with heated fluids at high flow for a medium BP of 80-90mmHg + Pressure at the place of haemorrhage + blood typing and analysis + dry and heat the patient.

If there is no response to fluids and bradycardia remains – consider neurogenic shock. -> Invasive hemodynamic monitorization and vasopressors.
D: Conscious, doesn't mobilize his limbs. E5V5M1.
He feels the anterior part of his neck until the clavicle. He can abduct his shoulder.

- ➔ Evaluate the level of the injury

If no attitude is taken (namely OTI) his consciousness degrades -> Glasgow 7 -> indication to intubate.

Debriefing planning (guided by the learning objectives and checklists)

Medical component	Group	Group	Group	Group
Systematic approach to the urgent/emergent patient				
1. ABCDE approach				
2. Identify the critical patient				
3. Ask for help				
Support measures				
1. Administer oxygen using a high flow mask				
2. Airway approach (trace a plan and why)				
3. Peripheral access and fluids				
4. Perform all of the actions considering there might be a cervical fracture				
5. Active heating				
6. Recognize medullar shock				
7. Consider using vasopressive medication				
In case of cardiac arrest				
1. Know the algorithm				
2. Identify causes of the arrest				
3. Correct potential causes				
Forwarding the patient				
1. Deciding where to direct the patient				
2. Describing the patient history and current state				
3. Preparing transport				
CRM				
1. Leadership				
2. Communication				
3. Using all of the information				
4. Cognitive support				
5. Verify, confirm and re-evaluate				

9.3 Appendix III – The Importance of Simulation in Team Training on Obstetric Emergencies: Results of the First Phase of the National Plan for Continuous Medical Training

ARTIGO ORIGINAL

Importância da Simulação no Treino de Equipa para Eventos Críticos em Obstetrícia: Resultados da Primeira Fase do Plano Nacional de Educação Médica Contínua

The Importance of Simulation in Team Training on Obstetric Emergencies: Results of the First Phase of the National Plan for Continuous Medical Training

Francisco MAIO MATOS, Andrea SOUSA GOMES, Fernando Jorge COSTA, Isabel SANTOS SILVA, Joana CARVALHAS

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RESUMO

As emergências obstétricas são eventos raros e inesperados. O modelo tradicional para a formação médica nestes eventos críticos apresenta limitações óbvias.

Dada a variedade de competências técnicas e o ambiente de alto risco em que são aplicadas, a obstetrícia é uma especialidade que se adequa totalmente ao treino através de novas técnicas ou tecnologias aplicadas à Medicina.

Este modelo de aprendizagem constitui uma oportunidade para aprender e treinar competências técnicas simples e complexas, bem como a oportunidade para ensaiar e aprender com os erros, sem risco para os doentes.

Assim, elaborámos um estudo com o objectivo de avaliar a percepção dos formandos relativamente a quais os factores associados à falibilidade humana antes e após a formação clínica com simulação; comparar o nível de confiança para a resolução de situações emergentes obstétricas entre internos e especialistas com mais de 5 anos de experiência, antes e após uma acção formativa em gestão de eventos críticos de Obstetrícia; e determinar o valor atribuído pelos formandos à simulação como instrumento formativo em cuidados emergentes. Nesta fase do programa, correspondente às 3 primeiras sessões formativas em gestão de eventos críticos de Obstetrícia, participaram 31 médicos. Após a acção formativa, verificaram-se alterações na percepção dos formandos relativamente a quais os factores associados à falibilidade humana, no nível de confiança para a resolução de situações emergentes obstétricas e no valor atribuído pelos formandos à simulação como recurso pedagógico.

ABSTRACT

Obstetric emergencies are unexpected and random. The traditional model for medical training of these acute events has included lectures combined with sporadic clinical experiences, but this educational method has inherent limitations.

Given the variety of manual skills that must be learned and high-risk environment, Obstetrics is uniquely suited for simulation. New technological educational tools provide an opportunity to learn and master technical skills needed in emergent situations as well as the opportunity to rehearse and learn from mistakes without risks to patients.

The goals of this study are to assess which are the factors that trainees associate to human fallibility before and after clinical simulation-based training; to compare the confidence level to solve emergent obstetric situations between interns and experts with up to 5 years of experience before and after training, and to determine the value that trainees give to simulation as a teaching tool on emergent events. 31 physicians participated at this course sessions. After the course, we verified changes in the factores that trainees associate to human fallibility, an increase in confidence level to solve emergent obstetric and an increase in the value that trainees give to simulation as a teaching tool.

INTRODUÇÃO

As emergências obstétricas são raras nos países desenvolvidos.[1,2] Estão associadas a elevadas taxas de morbilidade e mortalidade materna e perinatal. O seu tratamento eficaz requer uma abordagem clínica assertiva que possibilite uma estabilização rápida e evite complicações. Têm sido desenvolvidos algoritmos de actuação perante cada situação crítica. Todavia, o nível de adesão a estes algoritmos não é conhecido.

Segundo o relatório "Errar é Humano"[3] do Instituto de Medicina dos Estados Unidos da América (responsável pela definição da politica de saúde, informação e aconselhamento médico), o erro faz parte da existência humana e não pode ser evitado unicamente pelo esforço individual. Para melhorar a segurança e qualidade dos serviços de saúde, é imperativo reduzir a morbilidade e mortalidade associadas a acontecimentos evitáveis. Nos cuidados de saúde são identificáveis quatro factores contribuintes para o erro médico com consequência danosa: falibilidade humana (a possibilidade de erro inerente à condição humana), vulnerabilidade das barreiras defensivas (deficiências na criação de iniciativas que sinalizem e evitem o erro), complexidade e deficiências de sistemas (associadas à cada vez maior especificidade tecnológica).[4] É fundamental implementar as necessárias alterações sistemáticas que visem uma propensão para a realização correcta de cada procedimento, minimizando a frequência do evento adver-

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A.S.G., F.J.C., I.S.S., J.C.: Centro de Simulação Biomédica dos Hospitais da Universidade de Coimbra. Coimbra. Portugal.
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so e a gravidade da sua ocorrência.[5]

A equipa médica da sala de partos é composta por elementos com instrução, competências e experiência díspares, que trabalham em ambiente de elevada complexidade tecnológica - muitas vezes sem conhecimento prévio.[6] A gestão de eventos críticos requer conhecimento teórico/científico e competências técnicas (direccionadas para a realização de procedimentos especificos), psicomotoras (capacidade de realização simultânea de múltiplos procedimentos) e não técnicas/comportamentais (capacidade de avaliação clínica e decisória, liderança e comunicação eficaz).[7] Os planos de treino obstétrico existentes não relevam as competências não técnicas. O desenvolvimento da simulação permite o treino e avaliação destas capacidades sem colocar em risco o paciente e/ou equipa.[8,9] Procurando desenvolver estas capacidades, foram criados, nos centros de simulação dos Hospitais da Universidade de Coimbra e da Faculdade de Medicina da Universidade do Porto, cursos com simulação de Emergências em Obstetrícia.

Neste estudo, desenvolvemos um plano de formação em gestão de eventos críticos visando uma melhoria do desempenho das equipas perante estes eventos.

O número crescente de internos de Obstetrícia, a redução de horas de trabalho semanais e o aumento do volume de trabalho dos formadores, tem repercussão negativa no ganho experiencial adquirido.[6] A prática clínica com simuladores vem dar solução a alguns destes problemas, ao permitir o treino de equipa em situações clínicas com baixa incidência e risco elevado e possibilitar não só a ocorrência de erros como a avaliação dos seus precipitantes – prevenindo a sua repetição.

A utilização deste conceito educacional possibilita uma melhoria na curva de aprendizagem dos obstetras, com repercussão no seu comportamento clínico e evolução clínica dos doentes.[6] Em Portugal não existe, durante ou após o internato de Obstetrícia, treino obrigatório em situações críticas.

Os trabalhos que demonstram uma progressão significativa das competências médicas apresentam planos de formação com treino em distócia de ombros, hemorragia pós-parto, eclâmpsia, anafilaxia e tromboembolismo pulmonar.[6,10-13]

Os objectivos deste estudo são avaliar a percepção dos formandos relativamente aos factores associados à falibilidade humana antes e após a formação clínica com simulação; comparar o nível de confiança para a resolução de situações emergentes obstétricas entre internos e especialistas com mais de 5 anos de experiência antes e após uma acção formativa em gestão de eventos críticos de Obstetrícia; e determinar o valor atribuído pelos formandos à simulação como instrumento formativo em cuidados emergentes.

MATERIAL E MÉTODOS

Para este estudo prospectivo observacional, o Centro de Simulação Biomédica dos Hospitais da Universidade de Coimbra constituiu uma equipa multidisciplinar (obstetras, anestesiologistas e enfermeiros especialistas em saúde materna e obstetrícia) responsável pela criação de um curso de Gestão de Eventos Críticos em Obstetrícia. De forma a possibilitar o treino de competências técnicas e a aquisição de competências não técnicas, cada acção formativa de oito horas no Centro de Simulação Biomédica dos Hospitais da Universidade de Coimbra, era composta por duas apresentações teóricas (princípios da simulação médica e noções básicas de *crisis resource management* - CRM), dois cenários de simulação (escolhidos aleatoriamente de cinco pré-definidos - distócia de ombros, hemorragia uterina, eclâmpsia, anafilaxia e tromboembolismo pulmonar) e um *workshop* (abordagem da grávida crítica). Nos casos práticos com simulação de trabalho parto foi utilizado o simulador obstétrico *Noelle®* (*Gaumard Scientific®*), nos restantes foi usado o simulador *iSTAN®* (*METI® - Medical Technologies*).

Todos os cenários foram monitorizados por dois instrutores - um obstetra e um anestesiologista - que eram os facilitadores do *debriefing* após cada simulação. No *workshop*, um assistente de anestesiologia orientou a discussão e aplicação dos princípios gerais da abordagem da grávida em estado crítico. A distribuição dos participantes pelas acções formativas e grupos de trabalho de cada formação (3-4 participantes por grupo) foi aleatória. Participaram médicos especialistas e internos de Ginecologia/Obstetrícia com experiência em Obstetrícia – 10 participantes por sessão.

Todos os participantes responderam a um questionário no início, e após a sessão formativa, com o objectivo de avaliar mudanças na sua percepção em relação aos conteúdos em estudo.

O questionário inicial foi desenhado para caracterizar cada participante, avaliar quais os factores associados à falibilidade humana e o nível de confiança para a resolução de situações emergentes obstétricas. O questionário após o curso pretendeu comparar as avaliações iniciais e finais e determinar o valor atribuído à simulação como instrumento formativo em cuidados emergentes. A avaliação dos factores relacionados com a falibilidade humana, antes e após o curso, foi determinada pela quantificação da associação/selecção de 3 de 10 factores (comunicação, fadiga, stress, conhecimento, experiência, facilitismo, memória, erros de fixação, ausência de concentração, ruído) considerados mais determinantes.

Para avaliar o nível de confiança para a resolução de situações emergentes foi usada uma escala visual numérica de 10 pontos, preenchida antes e após o curso em resposta à pergunta "Como considera a sua experiência em emergências obstétricas?". Foram comparados os resultados pré e após o curso entre internos e especialistas.

O valor atribuído à simulação como instrumento formativo em cuidados emergentes foi aferido pela quantificação das respostas em escala de *Likert* de três pontos às perguntas "Qual o grau de utilidade que atribui à simulação no contexto de educação médica contínua?" (1 – sem utilidade, 2 – por vezes útil, 3 – muito útil) e "Estaria disposto

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Tabela 1 – Factores associados à falibilidade humana

Pré-curso		Pós-curso	
Fadiga	74,3%	Comunicação	87,1%
Comunicação	58,1%	Stress	61,2%
Stress	51,5%	Ruído	38,7%
Conhecimento	35,6%	Concentração reduzida	29,1%
Experiência	32,3%	Experiência	19,4%
Facilitismo	22,5%	Erros de fixação	19,3%
Memória	12,9%	Facilitismo	12,9%
Erros de fixação	9,6%	Conhecimento	12,8%
Concentração reduzida	3,2%	Fadiga	9,6%
Ruído	0	Memória	6,4%

a fazer certificação/re-certificação de competências num ambiente de simulação médica?" (1 – sim, 2 – não sabe, 3 – não) e pelas respostas em escala de *Likert* de cinco pontos às afirmações "A componente prática e experiencial da simulação é útil no treino de eventos críticos e vou alterar a minha prática clínica como resultado do que aprendi" (1 – concordo totalmente, 2 – concordo, 3 – sem resposta, 4 – discordo, 5 – discordo totalmente).

Foi aplicado o teste *T* de *Student* para a análise estatística do nível de confiança para a resolução de situações emergentes. Foram considerados significativos resultados com valor de probabilidade <0,05. A análise comparativa relativa às restantes questões foi descritiva.

RESULTADOS

Nas três sessões formativas participaram 31 médicos (oito especialistas e 23 internos). Os cinco factores mais associados à falibilidade humana no pré teste foram a fadiga (58,1%), comunicação (58,1%), stress (51,5%), conhecimento (35,6%) e experiência (32,3%). No pós teste os factores mais referidos foram a comunicação (87%), stress (61,3%), ruído (38,1%), concentração (29,1%) e experiência (19,4%) – tabela 1.

O resultado da avaliação do nível de confiança para a resolução de situações emergentes foi 4,14+/-2,12 (média+/-desvio padrão) antes do curso e 5,21+/-2,26 após o curso. As variáveis têm uma distribuição aproximadamente normal (*Kolmogorov-Smirnov*; *Shapiro-Wilk*). A análise estatística dos dados revela uma diferença significativa (*p*=0,011, teste de *T* de *Student*). Existe também uma diferença significativa entre os resultados de especialistas e internos no pré teste (*p*=0,004, teste de T de Student). Esta diferença não se verificou após o curso (*p*=0,480, teste de T de Student).

No final do curso, todos os participantes consideraram a simulação muito útil no contexto da educação médica contínua e 83% estariam dispostos a fazer certificação/re-certificação de competências num ambiente de simulação médica (17% não sabe). A importância da simulação é demonstrada por todos os participantes considerarem que a componente prática e experiencial da simulação é útil no treino de eventos críticos (83% concorda totalmente, 17% concorda parcialmente) e tem repercussão da prática clínica (74% concorda totalmente, 16% concorda parcialmente).

DISCUSSÃO E CONCLUSÕES

Os resultados dos factores mais associados à fiabilidade humana demonstram que a perspectiva autocentrada do ensino médico actual pode ser modulada pela experiência de situações críticas em ambiente controlado. A análise/*debriefing* da actuação durante os casos clínicos com simulação permite evidenciar a importância das competências não técnicas no trabalho de equipa; comprovada pelo destaque atribuído após o curso à má comunicação entre elementos da equipa e à experiência pessoal relacionada com a vivência de situações críticas – stress, ruído e concentração – que dificultam a percepção da gravidade da situação clínica, o estabelecimento de prioridades, a distribuição de tarefas e potenciam a ocorrência do erro.

A vivência de casos simulados possibilitou um aumento significativo do nível de confiança para a resolução de situações emergentes (*p*=0,011), evidenciando a mais-valia do processo de aprendizagem emocional aplicado ao treino de equipas. A diferença de confiança entre internos e especialistas diminuiu após o curso.

Estes dados são reforçados por todos os participantes terem considerado que a componente prática e experiencial da simulação é útil no treino de eventos críticos, relevando a sua importância no contexto da educação médica contínua. A recriação do ambiente clínico permite também identificar deficiências evitáveis de comportamentos e procedimentos possibilitando uma melhoria na prática médica[12] (objectivo de ensino classificado como *Kirkpatrick* 3) e possivelmente da morbilidade/mortalidade dos doentes[13] (objectivo de ensino classificado como *Kirkpatrick* 4). Destaca-se também a disponibilidade para a implementação de programas de formação e re-certificação pós graduada com simulação.

Sendo animadores, estes resultados devem ser valorizados considerando os limites deste estudo. O facto dos dois casos de emergências obstétricas não serem os mesmos nos três cursos, a discrepância da amostra em relação a nível de formação e experiência profissional, o possível factor de sensibilização para a segurança do doente atríbuivel à sessão teórica e a limitada representação da amostra, podem condicionar a interpretação destes dados.

Todavia, apesar destas condicionantes, a avaliação preliminar do programa nacional de formação em eventos críticos de Obstetrícia evidencia a importância da simulação como utensílio pedagógico na formação médica pós graduada. São necessárias mais acções formativas deste plano para reforçar estes dados e impor a utilização de casos simulados como processo de ensino adequado à realidade clínica quotidiana.

CONFLITO DE INTERESSES

Os autores declaram não ter nenhum conflito de interesses relativamente ao presente artigo.

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9.4 Appendix IV – Biomedical Simulation: Evolution, Concepts, Challenges and Future Trends

ARTIGO ORIGINAL

Biomedical Simulation: Evolution, Concepts, Challenges and Future Trends

Simulação Biomédica: Evolução, Conceitos, Desafios e Estratégias Futuras

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ABSTRACT

Biomedical simulation is an effective educational complement for healthcare training, both at undergraduate and postgraduate level. It enables knowledge, skills and attitudes to be acquired in a safe, educationally orientated and efficient manner. In this context, simulation provides skills and experience that facilitate the transfer of cognitive, psychomotor and proper communication competences, thus changing behavior and attitudes, and ultimately improving patient safety. Beyond the impact on individual and team performance, simulation provides an opportunity to study organizational failures and improve system performance. Over the last decades, simulation in healthcare had a slow but steady growth, with a visible maturation in the last ten years. The simulation community must continue to provide the core leadership in developing standards. There is a need for strategies and policy development to ensure its coordinated and cost-effective implementation, applied to patient safety. This paper reviews the evolutionary movements of biomedical simulation, including a review of the Portuguese initiatives and nationwide programs. For leveling knowledge and standardize terminology, basic but essential concepts in clinical simulation, together with some considerations on assessment, validation and reliability are presented. The final sections discuss the current challenges and future initiatives and strategies, crucial for the integration of simulation programs in the greater movement toward patient safety.
Keywords: Clinical Competence; Computer Simulation; Education, Medical/methods; Patient Safety; Patient Simulation; Portugal; Simulation Training.

RESUMO

A simulação biomédica é uma ferramenta educativa para a formação nas ciências da saúde, com aplicação nos vários níveis de ensino. Proporciona experiências ativas e sistemáticas de aprendizagem com o treino de conhecimentos, habilidades e atitudes, de forma segura, pedagogicamente orientada e eficiente. Neste contexto, a simulação biomédica proporciona habilidades e experiência que facilitam a transferência de competências cognitivas, psicomotoras e de comunicação, mudando assim o comportamento e atitudes, aumentando, em última instância, a segurança do doente. Para além do impacto sobre o desempenho individual e de equipa, a simulação proporciona o ambiente ideal para o estudo de falhas organizacionais e teste de melhorias nos desempenhos dos sistemas. Nas últimas décadas, a simulação na área da saúde cresceu lentamente, mas de forma constante, com um amadurecimento significativo nos últimos 10 anos. A comunidade de simulação deve continuar a liderar o estabelecimento de *standards* nesta área, assim como o desenvolvimento de estratégicas e políticas para assegurar a sua implementação coordenada e custo-efetiva, no aumento da segurança do doente. Este artigo apresenta os movimentos evolutivos da simulação biomédica, incluindo uma revisão das iniciativas portuguesas e programas nacionais. Para nivelar o conhecimento e padronizar a terminologia, são apresentados conceitos básicos, mas essenciais, da simulação clínica, juntamente com algumas considerações sobre avaliação, validação e fiabilidade. As seções finais discutem os desafios atuais e as iniciativas e estratégias futuras, cruciais para a integração de programas de simulação no movimento global de promoção da segurança do paciente.
Palavras-chave: Competência Clínica; Educação Médica/métodos; Portugal; Segurança do Doente; Simulação por Computador; Simulação de Doente; Treino por Simulação.

"Medical error—the third leading cause of death in the US" is the title of a recent published paper,[1] where an estimative of 251 000 deaths/year (in USA) are attributed to errors in patient care. Previous reports from the Institute of Medicine,[2,3] the National Healthcare System,[4] and other publications[5-6] attribute 70% - 80% of these errors to poor soft skills, namely communication, leadership, team work, among others. These reports have clear recommendations on the use of simulation to promote patient safety:

- "Another example of ways to prevent and to mitigate harm is simulation training. Simulation is a training and feedback method in which learners practice tasks and processes in lifelike circumstances using models or virtual reality, with feedback from observers, other team members, and video cameras to assist improvement of skills."[2];
- "The educational tools should include multimedia, small-group facilitated discussion, problem-based

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learning and simulation-based exercises. Only through innovative methods that encompass active learning, role modelling and feedback can changes in patient safety be fully realized."[4]

Simulation can be defined as a technique to replace or amplify real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner.[7] Simulation provides a safe, supportive educational environment,[8] encouraging acquisition of skills through experience, and stimulating reflection on performance.[9] As opposed to the clinical setting, where errors must be prevented or repaired immediately to protect the patient, in a simulated environment errors may be allowed to progress, to demonstrate their implications, or to enable a quick reaction to rectify them.[10]

Simulation is a learner-centered educational experience rather than a patient-centered activity. Trainees are exposed to a range of carefully designed clinical encounters, providing the opportunity for the educator to adapt the content, level of difficulty, and sequence in the curriculum,[10] in order to diagnose and bridge needs to best practices.

In this context, simulation provides skills and experience that facilitate the transfer of cognitive, psychomotor and proper communication competences, thus changing behavior and attitudes,[11] and ultimately improving patient safety.[12] Moreover, beyond the impact on individual and team performance, simulation provides an opportunity to study organizational failures and improve system performance.[12-14]

This paper reviews the evolutionary movements of biomedical simulation, including a review of the Portuguese initiatives and nationwide programs. For leveling knowledge and standardize terminology, basic but essential concepts in clinical simulation, together with some considerations on assessment, validation and reliability are presented. The final sections discuss the current challenges and future initiatives and strategies, crucial for the integration of simulation programs in the greater movement toward patient safety.

Biomedical simulation through times

Simulation, in its many forms, is widespread in several fields of human venture, counting many centuries of history.[15] In aviation, the first flight simulator appeared in 1928 through the work of Edwin Link.[16] The modern aviation industry has put a tremendous effort in the development of high-fidelity flight simulation and contributed to the improvement of teams training through crew resource management programs.[9]

In healthcare, primitive forms of simulation have been in use since the 16th century.[11] The earliest known simulators are obstetric manikins, introduced towards 1700 by Grégoire (Paris), for the practical instruction of midwives.[17] Physical models of anatomy and disease were constructed long before the advent of modern plastic or computers.[15]

The development of medical part-task trainers arose in late XIX century, although major proliferation was during the 1940s, with the development of plastic and synthetic materials.[19]

It was only in the 60s, that significant development originated a steady movement towards clinical simulation. In 1960, Äsmund Laerdal, a Norwegian toy manufacturer, developed the first trainer in the history of medical simulation. Resusci® Annie was initially designed for the practice of mouth-to-mouth breathing but rapidly an improved version was released for the training of cardiopulmonary resuscitation,[15] revolutionizing resuscitation training.

Other more sophisticated part-task trainers, such as Harvey (cardiology patient simulator) developed by Michael Gordon of the University of Miami Medical School, were developed in the late 60s.[9,18] Harvey played an important role on the development of more complex part-task trainers as it was the first to combined static models with audiovisual and interactive cues. Part of its innovation was the integrated curriculum of cardiovascular conditions, with associated learning goals.[18]

The use of standardized patients in medical education is thought to have begun in 1963.[10,19] This consists in (formal or informal) actors trained to role-play patients, for training and assessment of history taking, physical examination, and communication skills.

The first primitive full-body human patient simulator, Sim-One, was built by Stephen Abrahamson and Judson Denson at the University of Southern California in 1966, and was used for anesthesia training.[20] Two decades later, with the advances in computer technology and bioengineering, other high-fidelity simulators began to be developed, as a result of academic efforts.[21,22] Some of these went on to be commercial products, a few still currently available. One example is the CASE (Comprehensive Anesthesia Simulation Environment), developed by David Gaba at Stanford University which was commercially available for a number of years.[9,23] Another example is the Gainesville Anesthesia Simulator, developed by a group of researchers led by Michael Good and Joachim Gravenstein at the University of Florida, the precursor of many products currently commercialized by CAE Healthcare.[9,23] These simulators, and others developed in Europe, formed the grounds for the modern simulators currently available.

In the 90s, Delp and Colleagues developed the first surgical simulator to teach lower limb reconstruction surgery and, by the late 90s, basic virtual reality models were being commercialized.[24] Concerns on their efficacy put them on hold until 2002, when a double blinded study proved that trainees could reduce significantly their procedure times and that injury was reduced to a fifth, after using a virtual reality trainer.[24]

Prompted by technological innovation and reforms in healthcare education,[9] a more receptive atmosphere for the use of simulators started to emerge in the 1990s. Pressures arising from the limited receptivity of patients to be involved in training, limited instruction time, increasingly complex technical procedures, and ethical issues raised by the patient safety movement also contributed to these changes.[17,25]

In response to the expanding interest in this field, two societies were established: the Society in Europe for Simulation Applied to Medicine (SESAM – www.sesam-web.org) founded in August 1994, and the Society for Simulation in Healthcare (SSH - www.ssih.org), established in January 2004. Scientific publications entirely devoted to healthcare simulation emerged from these societies. Simulation in Healthcare (the official journal of the SSH) was launched in January 2006 and Advances in Simulation (the official journal of SESAM) released its first issue in January 2016.

These concomitant, yet asynchronous, movements were central to the understanding and development of simulation-based education, training and assessment. The anesthesiology community played an important role in the development of sophisticated full-body patient simulators,[20-23] and in the establishment of frameworks for the integrated training of technical and non-technical skills.[26-28] The development of simulation programs driven by learning needs (rather than simulation technology), including concepts of crisis resource management (non-technical skills required for effective teamwork in a crisis situation), led to significant advances in clinical team-based training.[29]

Biomedical simulation in Portugal

Simulation, in some basic forms, is present in Portuguese healthcare training since the 70s, mainly through the use of anatomic models and part-task trainers. In 1998, biomedical simulation was formally recognized as a research area, at the Institute for Biomedical Engineering (INEB), with the creation of the Modeling and Simulation Group. Several research projects were developed in close collaboration with international simulation companies, being some currently on the market.

The first record of a formal structured simulation center in Portugal dates to 2003.[30] Since then, other simulation centers were created or emerged from previous initiatives, both in public medical and nursing schools, as in public hospitals. Some private simulation centers have also been developed or have planned to start their activities in near future, although their scope is not made available yet.

Up to our knowledge (personal communications), there are around thirteen formally constituted simulations centers in Portugal, Table 1 (non-exhaustive list). Most of them started as in-house teaching facilities, dedicated to undergraduate or postgraduate training. A number of those evolved to national course providers reaching students and/or healthcare professionals throughout the country.

There has been a growing concern in faculty development, leading to formal instructor training in simulation and debriefing techniques in internationally recognized centers. Some instructors/centers have established collaborations and participate in faculty training abroad. In Europe, one of the most relevant in this area is the EuSim Group (www.eusim.org) which has a national representative and has performed several courses in Portugal in the past years.

Formal integration of simulation in healthcare sciences education has increased in the last years, benefiting of the current curricular reforms. Most national pre-graduated healthcare curricula have included simulation as an educational strategy to complement traditional methods. Some schools have also developed simulation-based post-graduate courses or residency training. One example is the hands-on obstetric courses, sponsored by the Colégio da Especialidade de Ginecologia/Obstetrícia da Ordem dos Médicos since 2009, available in several simulation centers throughout the country. Several simulation centers also offer carefully structured courses for anesthesiology residency training, and recently the Colégio da Especialidade de Anestesiologia da Ordem dos Médicos recommended the use of simulation in residency training.[31]

Research in biomedical simulation methodologies and tools continues to grow. Several national simulation centers have regular scientific production on the forms of MSc and PhD thesis, scientific indexed publications, technology

Table 1 - Portuguese simulation centers (non-exhaustive list). Sorted by geographic location.

Official name	Institution
Laboratório de Aptidões Clínicas	Escola de Medicina da Universidade do Minho
Centro de Simulação Biomédica da FMUP	Faculdade de Medicina da Universidade do Porto
Centro Biomédico de Simulação CHP/ICBAS	Centro Hospitalar do Porto / Instituto de Ciências Biomédicas Abel Salazar
Centro de Simulação Médica do Porto	Private
Centro de Simulação Clínica da Universidade de Aveiro	Escola Superior de Saúde da Universidade de Aveiro
Laboratório de Competências	Faculdade de Ciências da Saúde da Universidade da Beira Interior
Centro de Simulação Biomédica de Coimbra	Centro Hospitalar e Universitário de Coimbra
Centro de Simulação de Práticas Clínicas	Escola Superior de Enfermagem de Coimbra
Centro de Simulação de Práticas de Enfermagem	Escola Superior de Saúde de Portalegre
Centro de Simulação de Técnicas em Pediatria	Hospital de Dona Estefânia
Centro de Simulação Biomédica	Unidade de Ensino, Formação e Investigação da Saúde Militar, Forças Armadas Portuguesas
Laboratório de Aptidões	Departamento de Ciências Biomédicas e de Medicina, Universidade do Algarve
Centro de Simulação Clínica da Madeira	Serviço de Saúde da Região Autónoma da Madeira

Note: All websites accessed on Oct 31st, 2016.

transfer and participation on national and international scientific meetings.

In 2011, SPSim - Portuguese Society for Simulation in Health Sciences (www.spsim.pt) - emerged as a result of a collaborative project of most Portuguese medical schools and simulation training centers. With a wide range of representative members from most of the medical specialties and related health sciences, SPSim has been responsible for the promotion, dissemination and development of simulation based training, teaching and research in Portugal. Its mission includes:

1. Bring forward biomedical simulation as a training resource that contributes to patient safety, excellence of care and humanization of health care;
2. Contribute to the definition, implementation and monitoring of national strategies to apply simulation to health sciences teaching;
3. Promote national and international sharing, research and experience in biomedical education with simulation.

Although a young society, SPSim has the strength of a vigorous national network supported in international affiliations, as SESAM and SSH, and productive partnerships with strategic national societies, such as ABRASSIM (Brazilian Association of Simulation in Health - www.abrassim.com.br) and SESSEP (Spanish Society for Clinical Simulation and Patient Safety - www.sessep.com).

To promote national bounding and exchange of experiences, SPSim organized three national simulation meetings held in Braga (2012), Covilhã (2013) and Porto (2015). These events involved a large number of national and international participants, attracted by an appealing and experiential panel that addressed the major breakthroughs and developments in simulation applied to healthcare, from educational and/or clinical practice to research and technology.

Portugal has also received several major international healthcare simulation conferences: SESAM 2006 (Porto), SESAM-ALASIC 2009 (Coimbra), and SESAM 2016 (Lisbon). The later was organized by SPSim, being the first SESAM event organized by a national simulation society. The great success of SESAM 2016 potentiates and stimulates the expansion of biomedical simulation in Portugal.

Further information on specific programs or simulation centers can be consulted through the websites and contacts provided in Table 1.

Basic concepts of clinical simulation

Tools

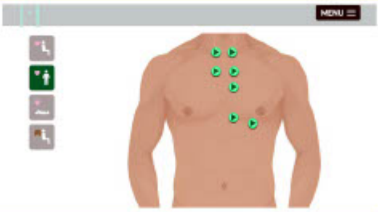
There are a number of simulation tools ranging from simple to complex, existing desktop software platforms, part-task trainers, full-body high fidelity simulators and live actors acting as standardized patients (SPs).[19] Each tool has a role in the simulation based learning cycle, and its correct use and application can potentiate the learning outcome, Table 2. Hybrid simulation, the combination of two or more tools – e.g. part-task trainer with standardized patient, should also be considered to augment the realism and to promote the integrated training of technical and soft skills.

Scenario design

The scenario should be designed and developed based on the learning objectives and expected learning outcomes.[29] These objectives must take into account the target audience and the training needs. If the acquisition of a technical skill is the learning goal, the scenario design is minimal and can simply be a part-task trainer placed on a table. On the other hand, if the learning goal is non-technical skills (or a combination of both), the design must be carefully thought, promoting the training of the specific skill(s) by challenging the participants in a realistic clinical case/environment. The later requires a higher investment in time, resources (human and equipment), and preparation. A scenario script/template is extremely useful to organize and standardize all aspects related with the scenario.

Location (city)	Website	Contact
Braga	https://www.med.uminho.pt/pt/Escola/Paginas/Laboratorio-de-Aptidoes-Clinicas.aspx	lac@med.uminho.pt
Porto	http://simulacao.med.up.pt	simulacao@med.up.pt
Porto	http://www.chporto.pt/pagina.php?id=19	centro.simulacao@chporto.min-saude.pt
Porto	http://www.cesimed.pt/	geral@cesimed.pt
Aveiro	https://www.ua.pt/essua/simula/	essua-simula@ua.pt
Covilhã	http://www.ubi.pt/Entidade/LaC	lac@fcsaude.ubi.pt
Coimbra	http://www.simcoimbra.org/	info@simcoimbra.org
Coimbra	https://www.esenfc.pt/pt/page/3487	esenfc@esenfc.pt
Portalegre	http://www.essp.pt/novo/index.php/links-de-interesse/80-artigos/154-simula-enfer	geral@essp.pt
Lisboa	https://cstpediatria.wordpress.com/	pmcgarcia@gmail.com
Lisboa	http://www.emgfa.pt/pt/organizacao/dirsam/uefism	Not available
Faro	https://dcbm.ualg.pt/pt/content/laboratorios-aptidoes-lab	dcbm@ualg.pt
Funchal	https://www.sesaram.pt/cscm/	pedromcr60@gmail.com

Table 2- Biomedical simulation tools

Category	Description	Application	Example
Standardized patients	(Formal or informal) actors trained to role-play patients or relatives	For training and assessment of history taking, physical examination, and communication skills	
Part-task trainers	Represent a part of the body and often consist of a limb, or other body part or structure	Intended for the training of technical, procedural or psychomotor skills	
Complex task trainers	Combine static models with audiovisual and interactive cues. Virtual reality simulation can be included in this category.	Training and assessment of complex procedures or tasks	
Screen-based (software)	Can be simple self-tutorials or more sophisticated tool reacting appropriately to the trainee actions, and providing feedback on decisions and actions	Training and assessment of clinical knowledge and decision making	
Full-body patient	Consist of a full-body manikin, a computer workstation, and interface devices that activate manikin signs and drive emulated or actual monitors	Training of complex and high-risk clinical situations in a lifelike team training setting	
Hybrid	Combination of two or more of the above tools	Augment the realism and/ or to promote the integrated training of technical and soft skills	

Accordingly to the degree of complexity of the skill being practiced or tested, a certain level of fidelity or realism might be more or less suitable.

Simulation session

A simulation session typically includes three stages: briefing, scenario and debriefing/ feedback.

1. **Briefing**. Provides a ground for the simulated

experience and promotes the engagement of the trainee(s). Briefing the room, equipment, and the simulation process (including debriefing/feedback) is essential for a valuable learning experience;

2. The scenario. Consists in the actual performance of a trainee or trainees in a specific simulated situation. It can range from basic settings for individual technical skills training to immersive environments for team training;

3. Debriefing and feedback. These remain fundamental elements of simulation-based learning.[32] Feedback is specific information about the comparison between a trainee's observed performance and a standard, and is given with the intent to improve/enhance the trainees' performance (mainly on technical skills). Debriefing is an assembly of participants and facilitator(s) in which a recent event can be recalled, analyzed and reflected upon in order to agree on future practice changes. Typically topics that may benefit from debriefing are team training, crisis resource management skills and multidisciplinary training.[33] Feedback is mostly what was done and debriefing is mostly why it was done.

Assessment, reliability and validity in clinical simulation

Assessment

Assessment is one of the most significant events in the life of a higher education trainee both at pre- and post-graduate levels. Besides its role in establishing the level of one's competency, assessment is one of the most powerful drivers for learning. Assessment should be part of an integrated approach to teaching/learning process in which assessment may be part of the feedback process, quality assurance or licensing steps. This constructive alignment of the educational process[34,35] is paramount to ensure that the learning goals projected for each level of training reaches the desired. According to Miller,[36] the medical graduate development progresses from purely cognitive knowledge level (Knows, Knows how) at the novice stage through increasing levels of operational tasks (Shows how) that characterize the competent trainee until it reaches the practicing expert (Does). While it is possible to assess the first levels with written exams and other cognitive tools it is impossible to use them to test procedural skills. The use of simulation tools provides therefore a mean to test higher levels of competency in a standardized environment while at the same time avoiding any harm to patients.

Assessment can be used with different goals according to the necessity of the student/institution, namely:

1. Identify learning needs;
2. Set professional standards of competence and performance;
3. Rank applicants for recruitment.

In the first situation, also known as formative assessment, simulation tools are used as a means to identify the trainee needs at a specific level of development. This has been the mainstay of several simulation courses and programs that rely on feedback techniques specially designed to imprint permanent changes in behavior that lead to best practices.[37] Although these assessment tasks are generally considered as low stakes, since they do not have a direct impact on the trainee's curricular progression they can be powerful modulators and have a direct impact on the practice of clinicians and ultimately lead to improved care.[38]

Assessment aiming at goals 2 and 3 is referred as summative assessment and is characterized as of high stakes (e.g. setting minimal competency to pass a final) or high-high stakes (e.g. if is a life determining decision such as a licensing exam). In either case, clinical simulation provides an affordable mean to test procedural tasks with high reproductivity in a realistic environment. Part-tasks trainers are inexpensive allowing the reproduction of several procedural tasks (e.g. IV-line placement) that could not be assessed in real life conditions without comprising patient safety. Standardized patients and full-body high-fidelity simulators are more expensive to acquire and maintain but provide a highly realistic scenario that is useful to test complex tasks such as history taking or teamwork.

Reliability and validity

Reliability and validity are concepts intimately related to the assessment process.[39] Reliability refers to the desired consistency (or reproducibility) of test scores. In other words, it is the degree to which individuals' deviation scores remain relatively consistent over repeated application of the same test or alternate test forms. Validation is a process by which a test developer or test user collects evidence to support the types of inferences that are to be drawn from test scores. There are two main categories used to assess the validity of a test: content (appropriateness of content) and criterion (relation to other measures).

Simulation based assessment presents issues concerning both reliability and validity. Despite the fact that one of the advantages of using simulators and standardized patients is the consistent reproducibility of behavior, reliability is typically not very high in these settings when compared to assessment of cognitive skills (e.g. multiple choice items). This phenomenon can be ascribed to a sampling effect since simulation based assessment typically comprises a limited number of stations for any number of reasons (limited number of simulators, time, logistics, etc.), especially if the assessment is based in a small number of long duration simulation sessions. To limit this effect, many institutions have adopted some form of OSCE (objective structured clinical examination) assessment with a significant number of stations (8 to 12), with more objective and time limited scenarios.

The most important aspect to reach adequate reliability is the time spent during the assessment.[40] Another source of variance that affects reliability is the nature of the scoring system (automatic vs human dependent) and how the scorer interferes with the scenario itself. If the scorer is a third-party present in the room, there is a bias effect of the candidate knowing that there is a direct observer leading to conscious behavior towards pleasing/probing the scorer in the room. There are several solutions to overcome these issues namely, using video recordings/streaming in order to isolate the scorer from the scenario, using SP as the scorer, using one-way windows, etc. Additionally, the training effect that is observed in candidates is considerable reducing the possibility to test in different conditions than those that were applied during training, especially when using part-task trainers. This phenomenon is less evident with SPs or scenarios designed to assess soft skills since there is more liberty to variations in scenario.

Current challenges

Choosing the correct simulation tool for the selected learning objective(s) is a permanent challenge. The continuous development of more sophisticated simulation tools provides a spectrum of possibilities towards clinical simulation. Nevertheless, low-cost approaches can equally provide effective learning and have the potential to be used globally. Inexperienced simulation users are many times tempted to use highly sophisticated equipment inadequately, creating artificial and unrealistic scenarios with unnecessary complexity.

Integrating simulation-based training into healthcare curricula continues to be a challenge. Ideally this integration should be transversally to the different levels of education, to ensure the continuity between simulated and clinical learning environments. If the curricula are artificially adapted to include simulation encounters, it can promote negative learning.[41] Poorly designed simulation scenarios and inadequate instruction may encourage shortcuts, such as omitting patient consent and safety procedures, or it may promote unnatural rather than genuine communication skills.[41] Moreover, although simulation is widely used for teamwork training, the full integration of surgical, anesthetic, nursing and other key members of a healthcare team (e.g. operating room team) remains a challenge.[42]

Validity in simulation based assessment is an important issue. While content validity is usually achieved at the level of the construct, face validity is many times challenged by assessors and assesses. These issues are mainly related to the unrealistic nature of some models and mannequins that obstacles to the participant to perceive a scenario as real (e.g. cyanosis is very difficult to represent although it is a relevant alert sign). Criterion validity (the possibility to predict later performance in a related criterion) is difficult to achieve, but when achieved it generates real impact in patient outcomes.[38] It is questioned if learning to perform a task in a mechanical model leads to adequate changes in behavior or if it reflects a training effect similar to playing a video-game. Despite all these challenges, a well-designed simulation based assessment can achieve high standards and are used in several licensing exams throughout the world.[43,44]

Translational research and evidence-based studies of the impact of simulation on patient safety are sparse. In scientific literature, there are innumerous satisfaction studies or educational impact studies supporting systematic acceptance and widespread use of simulation but only few studies[45,46] show evidence of simulation-based training in patient outcomes. These studies are demanding and costly but essential to better understand and demonstrate the real impact of simulation on patient safety.

The sustainability of simulation programs is dependent of multiple factors such as: institutional commitment,[47] strong leadership,[47] a curriculum relevant to clinical practice,[47] funding,[48] adequate equipment,[47-49] faculty development, stable group of instructors and technicians, among others. Consistent funding for both human and physical resources is essential to address long-term goals of the programs.[49] An understanding of the cost-effectiveness of simulation will enable educators, institutions and healthcare systems to make informed choices with regard to the use of simulation-based medical education programs.[13]

The future: moving towards excellence

Over the last decades, simulation in healthcare had a slow but steady growth, with a visible maturation in the last ten years. Simulation-based training has been proved to be an effective educational complement for clinical skills acquisition.[46] It enables knowledge, skills and attitudes to be acquired in a safe, educationally orientated and efficient manner, facilitating the transfer of cognitive, psychomotor and soft skills to improved patient care and better patient outcomes.

To move towards excellence and overcome the current challenges, a number of initiatives must be implemented and developed[7]:

1. Integrating different types of simulation across different dimensions of applications, purposes, and target populations;
2. Assessing the impact or benefit of simulation based training across the various dimensions;
3. Developing applications for units of participation larger than clinical teams (e.g. entire health care organizations);
4. Establishing benchmarks and criteria for competency based performance assessment using simulation;
5. Investigating fundamental aspects of human performance in health care using simulation;
6. Use of simulation for usability testing of medical devices and patient care processes, if possible at an early, prototype stage, and before deployment.

The simulation community must continue to provide the core leadership in developing standards.[7] Some efforts have been made to set a ground for this process: SSH accreditation of healthcare simulation programs was implemented in 2010; SESAM accreditation of simulation based educational institutions started this year; the Aspire Initiative from the Association for Medical Education in Europe (AMEE) will include in 2017 biomedical simulation in the subjects recognized with excellence in education.

Moreover, simulation community must also take the responsibility of implementing strategies for the use of simulation to improve patient safety.[7] National and international simulation societies, together with healthcare

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and education stakeholders, must lead these initiatives, promoting integrated and funded training programs for healthcare providers at all stages. Policy development is needed to ensure its coordinated and cost-effective implementation. Instead of an independent educational initiative, it should be integrated in the greater movement toward patient safety. As Gaba[7] stated in his vision, in 2004, "the major revolution enabled by simulation can only be achieved if the relevant applications are fully integrated into the routine fabric of health care delivery."

PROTECTION OF HUMANS AND ANIMALS

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the Helsinki Declaration of the World Medical Association.

DATA CONFIDENTIALITY

The authors declare having followed the protocols in use at their working center regarding patients' data publication.

CONFLICTS OF INTEREST

All authors are board members of SPSim and simulation instructors in national or international public and/or private institutions. LP is CEO at UpHill, Lda. JMP is an associate of iCognitus4ALL – IT Solutions. None of these companies or institutions influenced, participated or contributed to the content of this paper.

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Chapter 10: Attachment

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Publisher: Wolters Kluwer Health, Inc.

Date: Apr 1, 2013

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10.2 Attachment II – Approval from Ethical Committee

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Comissão de Ética para a Saúde

Visto/ À U.I.D.
para difusão

__/__/____

Exmo. Senhor
Dr. Francisco Matos
Digm° Responsável pelo Centro de Simulação Biomédica do CHUC

SUA REFERÊNCIA	SUA COMUNICAÇÃO DE	NOSSA REFERÊNCIA	DATA
		N.º 171/CES Registo N.º 011/19	25-07-2019

ASSUNTO: Validação dos princípios éticos de estudo de impacto educacional do Centro de Simulação Biomédica do CHUC

Cumpre informar Vossa Ex.ª que a CES - Comissão de Ética para a Saúde do Centro Hospitalar e Universitário de Coimbra, reunida em 18 de Julho de 2019, tendo recebido o pedido de validação dos princípios éticos de estudo de impacto educacional do Centro de Simulação Biomédica do CHUC intitulado "A simulação como recurso pedagógico no ensino médico", após a análise retrospetiva do respetivo processo, assumida a título excecional, considerou que se encontram respeitados os requisitos éticos adequados à realização do estudo, pelo que emitiu parecer favorável ao seu desenvolvimento no CHUC.

Com os melhores cumprimentos,

A Comissão de Ética para a Saúde do CHUC, E.P.E.

Prof. Doutor João Pedroso de Lima
Presidente

CES do CHUC: Prof. Doutor João Pedroso de Lima, Prof. Doutora Margarida Silvestre, Enfº Adélio Tinoco Mendes, Dra. Cláudia Santos, Dra. Isabel Ventura, Dr. José António Feio, Rev. Pe. Miguel Ferreira, sj, Dr. Pedro Lopes, Dra. Teresa Monteiro

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