National Pedagogical Plan in Anaesthesiology: Exploring the Impact of Simulation Training During Residency in Portugal

Plano Pedagógico Nacional de Anestesiologia: Avaliação do Impacto do Treino com Simulação Durante o Internato em Portugal

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ABSTRACT

An optional simulation training programme for Anaesthesiology residents was developed and incorporated into a National Pedagogical Plan at the Biomedical Simulation Centre of Centro Hospitalar e Universitário de Coimbra, Portugal, tailored to each specific year of residency. This study aimed to evaluate participants' assessment of the module and its perceived impact.

Methods: Confidential pre- and post-module questionnaires were completed by all the residents who attended the simulation modules between February 2011 and March 2018.

Results: A total of 340 questionnaires were answered. Residents' self-assessment of the importance of core concepts in Anaesthesiology increased significantly during the Year I and Year II modules (p <0.05) and then plateaued until the end of year IV. Self-assessment regarding training also improved from the pre-Year I module to the end of Year IV (p <0.05). Nevertheless, significant fluctuations were observed when comparing pre-post responses within the same module (p <0.05) and when comparing post-module scores with the pre-module scores of the following year (p <0.05). An exception was observed in advanced life support (ALS) training, which showed a marked increase during the Year I module and subsequently remained consistently high until the final year. In contrast, self-assessment of overall experience and training followed a similar trajectory with less pronounced fluctuations over the course of the programme.

Conclusion: Self-assessment of the role of simulation in Anaesthesiology training was positive, with the greatest gains noted during the first year of the residency. These findings suggest that the implementation of a national

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simulation-based training initiative enhances self-perceived competence in key domains essential to a robust educational programme.

KEYWORDS: Anesthesiology; Internship and Residency; Medical Education; Simulation Training

RESUMO

Introdução: O Centro de Simulação Biomédica do Centro Hospitalar e Universitário de Coimbra, em Portugal, desenvolveu um programa opcional de formação com simulação, integrado num Plano Pedagógico Nacional destinado a médicos internos de Anestesiologia. O programa foi estruturado de forma diferenciada para cada ano do internato médico. Este estudo pretende avaliar a perceção dos participantes relativa ao módulo e ao seu impacto.

Métodos: Foram aplicados questionários confidenciais antes e após a realização de cada módulo, preenchidos por todos os internos que frequentaram os módulos de simulação entre fevereiro de 2011 e março de 2018.

Resultados: Foram obtidos 340 questionários. A avaliação dos internos quanto à importância de vários conceitos-chave em Anestesiologia aumentou significativamente durante os módulos do 1º e 2º anos (p <0,05), estabilizando posteriormente até ao final do 4º ano. A autoavaliação relativa ao nível de formação também evidenciou um aumento significativo e consistente do início do 1º ano até ao final do 4º ano (p <0,05). Ainda assim, registaram-se flutuações estatisticamente significativas entre a avaliação pré e pós de todos os módulos (p < 0,05), bem como entre os resultados pós-módulo e os resultados do pré-módulo do ano seguinte (p < 0,05). A principal exceção foi observada na formação em suporte avançado de vida, que apresentou um aumento importante durante o módulo do 1.º ano, mantendo-se elevada e estável até ao final do último módulo. Por outro lado, a autoavaliação da experiência e da formação global seguiu uma evolução semelhante, mas com flutuações menos acentuadas ao longo dos diferentes anos.

Conclusão: A autoavaliação do papel da simulação na formação em Anestesiologia é globalmente positiva, sendo mais expressiva no primeiro ano do internato médico. Os nossos resultados sugerem que a implementação de uma iniciativa nacional de formação baseada em simulação potencia a perceção de competência em domínios essenciais para a consolidação de um programa educacional robusto.

PALAVRAS-CHAVE: Anestesiologia; Educação Médica; Internato e Residência; Treino com Simulação

INTRODUCTION

Simulation education has been a trend and is now recognized as part of medical education, mainly due to decreased opportunities to practice in real-world situations and concerns about patient safety.[1-4]

In Anaesthesiology, the number of challenging technical procedures is increasing, leading to a higher incidence of procedure-related complications, particularly when the anaesthesiologist is not adequately trained.[2-7] Therefore, it is essential to develop strategies to address these issues, in alignment with the ethical imperative to ensure the safety of both patients and healthcare professionals.

Medical simulation in Anaesthesiology has shown promising results regarding effectiveness and efficiency.[6-8]

To bridge the gaps in Anaesthesiology teaching and to integrate the simulation as a pedagogical reference tool, the Biomedical Simulation Centre of Centro Hospitalar e Universitário de Coimbra (BSC-CHUC), Portugal, offers an optional pedagogical plan (National Pedagogical Plan) to all Anaesthesiology residents. This plan comprises four simulation modules designed according to the curricular goals defined by the specialty board and in a team-oriented way.[9-11] The curriculum development occurred based on a six steps approach: step 1: problem Identification and general needs assessment; step 2: needs assessment for each year of residency; step 3: goals and objectives – aligned with the curricular requirements defined by the Portuguese Board of Anaesthesiology; step 4: select and apply adequate educational strategies; step 5: design the strategy of implementation; step 6: definition of evaluation and feedback indicators – carried out by a group of experts comprising hospital coordinators of the Anaesthesiology residency programme, all of whom had received specific training as simulation instructors.

The evaluation of simulation-based training as an ed-

ucational tool presents a challenge, owing to the need for objective and reliable assessment instruments. Accordingly, we developed structured questionnaires to obtain participants' evaluations of the training modules.[11]

Therefore, this study aimed to evaluate the progression and perceived impact, through self-assessment, of Anaesthesiology residents enrolled in the simulation programme at BSC-CHUC over the four years of specialist training. This assessment was based on confidential questionnaires administered in person, before and after each specific simulation module, including individual and team learning, behaviour, and course evaluation questions. Skills, knowledge, and attitudes are integral components of clinical performance, and the presented study focuses on the technical aspects of the learning and training process.

Although this work was conceptually grounded in Anaesthesiology training, the findings of our study are potentially applicable across all fields of medical education. Accordingly, we aimed to explore the role of simulation in influencing individual and team learning, corresponding to Level 1 (Reaction) of the Kirkpatrick model.[12-16]

METHODS

STUDY DESIGN

This prospective observational study was designed to evaluate the impact of the Anaesthesiology National Pedagogical Plan of BSC-CHUC in the self-assessment of confidence, behaviour, and training of Portuguese Anaesthesiology residents. Residents who participated in the optional simulation modules completed an in-person questionnaire, before and after each simulation module, designed according to the program contents of each year of the Anaesthesiology Residency Program (ARP) (Table 1).[11]

Questionnaires that had been previously developed, validated, and translated into English[17] included items addressing learning, behavioural components, and the evaluation of the pedagogical content of each simulation module. The draft questionnaire was designed by two anaesthesiologists with experience in simulation. To ensure face and content validity, the items were reviewed for clarity, syntax and relevance by a panel of 5 experts with recognised expertise in simulation-based Anaesthesiology training. The questionnaires were administered to 30 participants of the Anaesthesiology National Pedagogical Plan from BSC-CHUC, in two pilot-courses. These participants were Anaesthesiology residents from CHUC belonging to the target group of the questionnaires.

TABLE 1. Programmatic content of each simulation module

Year I	• Basic pharmacology in Anaesthesiology • Basic and advanced airway • Ventilation • Ultrasound in Anaesthesiology I • Central and peripheral cannulation using ultrasound • Neuraxial anaesthesia and local anaesthetics • ALS
Year II	• Leadership and health management • Difficult airway management • Supraglottic and transcutaneous devices • Fibroscopy principles • Ultrasound in Anaesthesiology II • Regional blocks • Anaesthetic approach to the burn 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 • Operating room (OR) emergencies

Learning questions were the same across the four years (horizontal questionnaire – Table 2).

SETTING

This was an observational study conducted in Portugal, between 2011 and 2018, at the BSC-CHUC. The same simulation modules were offered at BSC-CHUC on a consistent and optional basis from February 2011 onwards.

PARTICIPANTS

Four participants were included in each section with the roles of senior fellow (1st help), fellow, and 2 residents, according to each scenario. Each scenario included an actor and an instructor, who set the scene for the simulation and assigned the roles. All residents were active in hot seats. The scenarios' script was related to each module's content, described in Table 1, and representative ones are included as supplementary data (Addition-

TABLE 2. Horizontal questionnaire for evaluation over the 4 years of Anaesthesiology Simulation Pedagogical Plan. These questions were performed pre-and post-simulation modules in each year of the residency in Anaesthesiology.

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 ALS?
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 ALS?
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 clinical daily practice
Q20	Simulation team training may have an impact on patients' clinical outcome

*Questions only apply to the 3rd year questionnaire

al file 1). Each scenario was preceded by a briefing that set the scene for the simulation and assigned the roles. Participants should know who they are, where they are, and what their role is. Participants were all Anaesthesiology residents who participated in the optional simulation modules at BSC-CHUC, and this was the only inclusion criterion to participate in this study.

PATIENT SIMULATION

The mannequins used were 2 iStan (CAE), 1 PediaSIM (CAE), 1 SimBaby (Laerdal), and 1 Noelle (Gaumard). All the performed modifications are specified in the scenario scripts that include technical and non-technical pedagogical goals. These goals are also structured in all the points of the debriefing. (Additional File 1).

SIMULATION ENVIRONMENT

All the scenarios were developed at the simulation centre. 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, which maintains all the atmosphere of a surgery room, a post-anaesthetic 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 module, with the number of modules 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 Anaesthesiology 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.

TIMELINE AND DESIGN

Simulation modules were performed during the first trimester of each specific year, 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 Anaesthesiology Board of the Portuguese Medical Association 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 was aligned with the goals for each year of training designed by the Anaesthesiology Board of the Portuguese Medical Association. To sustain the learning process, educational support and small lectures were given.

DEBRIEFING

Following each scenario, the instructor facilitated a structured debriefing. Each scenario was followed by a debriefing session approximately three times longer than the simulation itself, with two facilitators present. All debriefings followed three distinct phases: description, analysis, and application, concluding with key take-home messages.

VARIABLES AND METHOD OF ASSESSMENT

All variables were collected on an anonymized database specifically designed for the study. The source of all the variables were the specific questionnaires applied before and after each simulation module. 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).

BIAS

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

QUANTITATIVE VARIABLES

All collected variables were quantitative.

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).

RESULTS

A total of 340 answered questionnaires were included in the study: the first-year module 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. Seventy-four percent of the responses belong to female patients. All residents were affiliated to a regional or district hospital. None had other experience with high-fidelity simulation programs.

All figures, except Fig. 4, are grouped in panels corresponding to different groups of questions, except Panel A. Panel A corresponds to the first question, a general one, regarding each student's perception about critical events in the operating or emergency room (Q1 – Table 2). Panels B, C, and D include questions regarding the importance given by the student to critical points in Anaesthesiology (Q 2 – Table 2), the perception of each student about their training in the same critical points in Anaesthesiology (Q3 – Table 2) and each student's own experience in the same critical points in Anaesthesiology (Q4 – Table 2), respectively. Panel E includes questions about the role of simulation training in the educational process (Q17, Q18, Q19, and Q20 – Table 2).

PRE-MODULE SELF-EVALUATIONS

Fig. 1 presents all pre-module self-evaluations conducted annually, allowing comparison across all four years. When comparing Year I with Year II, all panels show a significant increase in scores, except for the items related to the importance attributed to critical points in Anaesthesiology (Panel B). This suggests that students were already aware of the key concepts in Anaesthesiology from the outset of their training. The only notable exception was the increased importance attributed to neuromuscular blockade in the pre-Year II assessment compared to pre-Year I.

Regarding comparing Year II to III, it is essential to note the decrease in panel A, demonstrating an increase in the awareness about the students' preparation for critical events. In the importance attributed to (panel B), students gave more importance to ventilatory, cardiac, and neuromuscular block monitoring in the third year. The perception about training in the management of critical events also increased from the second to the third year (panel C). It is interesting to point out the decrease noted in clinical practice experience and the increase in the experience in difficult airway management (panel D). From the second to the third year, students gave more importance to simulation as a complement to the Anaesthesiology resident program (panel E).

From Year III to IV, it is possible to verify a stabilization in almost all variables. The exceptions were in panel B, particularly in the importance given to cardiac monitoring, which is higher in the fourth year; in panel D regarding the experience in the management of critical events that are higher in Year IV; in panel, E showing that students ultimately agreed on the importance of periodic simulation actualizations in Year III and also agreed with the fact that simulation could impact the clinical evaluation of patients.

POST-MODULE SELF-EVALUATIONS

Fig. 2 shows all post-module evaluations at each year, comparing all years. From Year I to Year II, students increased their awareness about their preparation in critical events in the operating or emergency room (Panel A). There was an increase in the importance

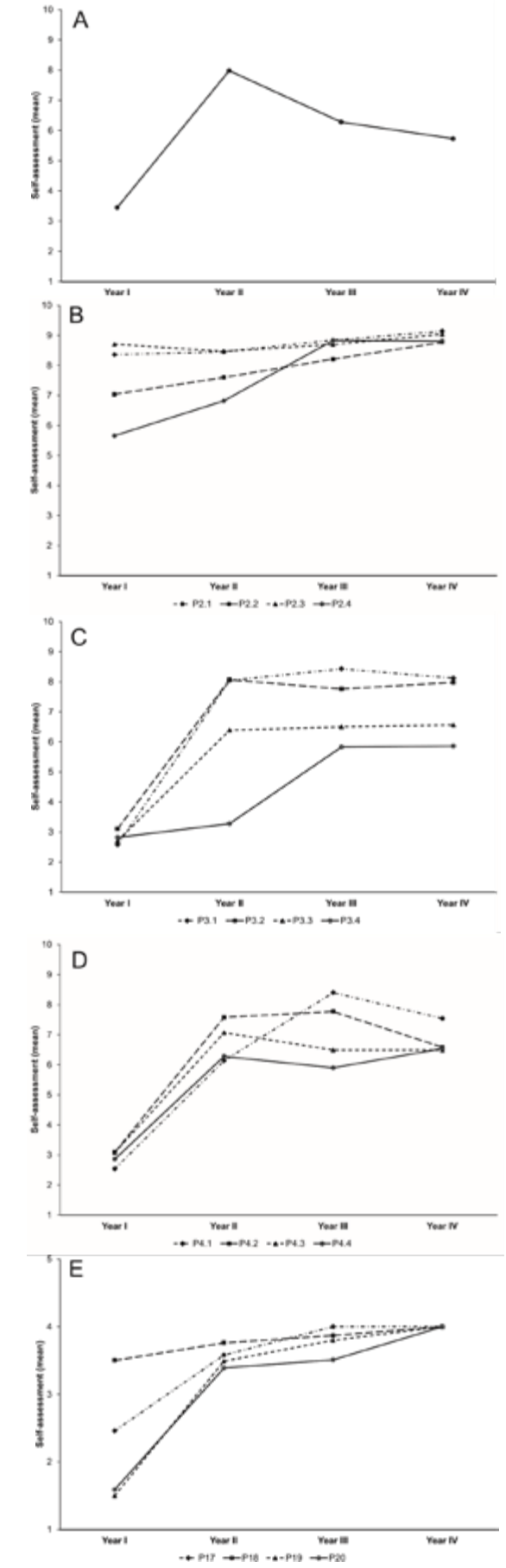

FIGURE 1. Pre-module self-evaluations performed at each year, comparing all years (Mean). **Panel A:** Q1 – Table 2; **Panel B:** Q2 – Table 2; **Panel C:** Q3 – Table 2; **Panel D:** Q4 – Table 2; **Panel E:** Q17, Q18, Q19 and Q20 – Table 2.

given to airway management and cardiac monitoring (panel B), in the level of evaluation about their training in ALS and emergencies during clinical practice (panel C), in their experience in difficult airway management, in emergencies during clinical practice and in the management of critical events (Panel D), and in the level of agreement regarding the importance of simulation team training during the residency program (Panel E).

From post-module Year II to Year III, students perception of preparedness to deal with critical events in the operating or emergency room reduced (Panel A), demonstrating a raised awareness of their self-efficacy; increased the importance given to ventilatory monitoring and neuromuscular monitoring (Panel B), the evaluation of their training in airway management, emergencies during their clinical practice and in the management of critical events (Panel C), the experience in emergencies during clinical practice and decreased the confidence about their experience in the management of critical events (Panel D). There was also an increased agreement regarding the importance of simulation team training during the residency program (Panel E).

Comparing Year III with Year IV, there was an increase in the confidence regarding preparedness to deal with critical events in the operating or emergency room (Panel A), no differences in the importance attributed to critical points of anaesthesiology (panel B), and an increase in the level of training about critical events management (Panel C). The level of experience also increased in ALS and critical events management (panel D), and no differences regarding the importance of simulation training (Panel E).

EVALUATION OVER TIME

Fig. 3 analyses all evaluation moments, showing a significant evolution of the students during each simulation module (pre-post analysis). In the first year, there was a significant improvement in all the questions. In the second year, the differences were also significant, except the evaluation of training level in ALS and the agreement regarding the inclusion of simulation in a periodic updating plan, both of which remained unchanged compared to Year I. In the third year, there were four questions whose answers did not change before and after the simulation module: the importance of neuromuscular blocking, the experience of difficult airway management, the inclusion of simulation in a periodic actualization plan, and the impact of simulation in the improvement of clinical practice. In Year IV, similar to Year III, the importance of neuro-

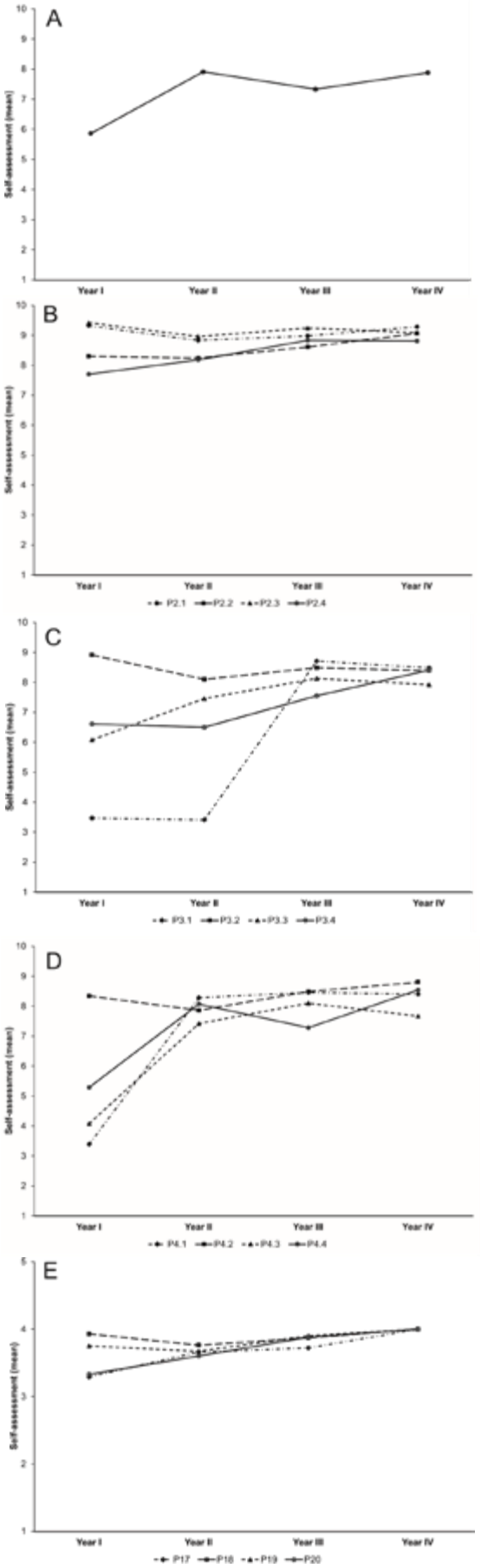

FIGURE 2. Post-module self-evaluations performed at each year, comparing all years (Mean). **Panel A:** Q1 – Table 2; **Panel B:** Q2 – Table 2; **Panel C:** Q3 – Table 2; **Panel D:** Q4 – Table 2; **Panel E:** Q17, Q18, Q19 and Q20 – Table 2.

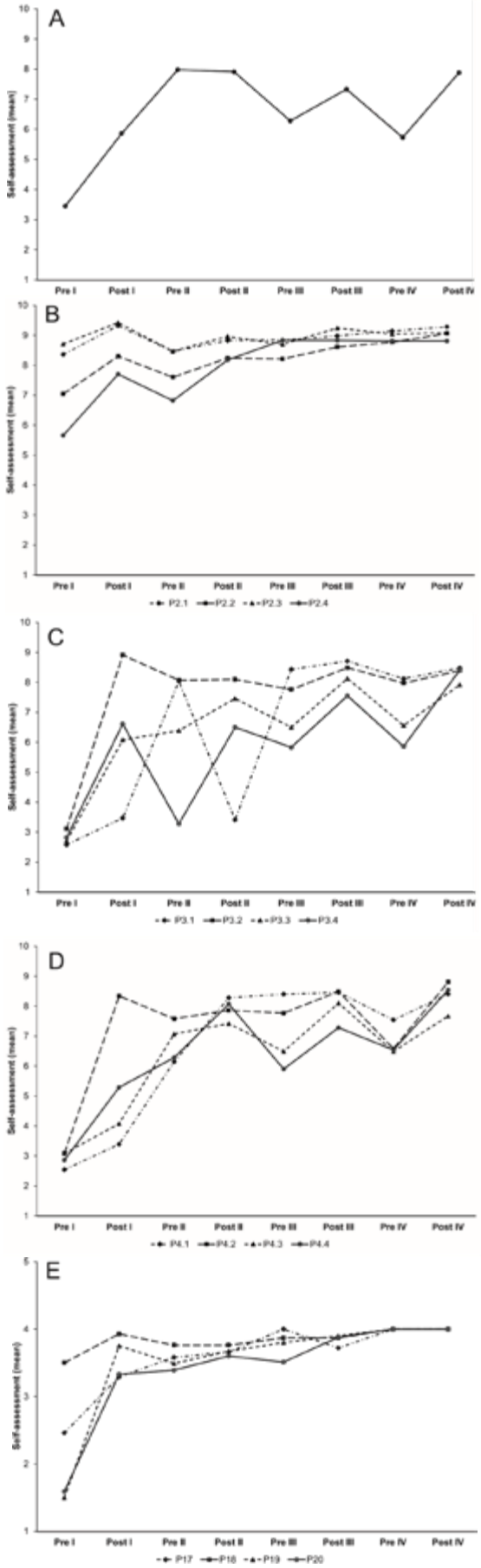

FIGURE 3. Evaluation over time comparing pre-module and post--module at all evaluation moments (Mean). **Panel A:** Q1 – Table 2; **Panel B:** Q2 – Table 2; **Panel C:** Q3 – Table 2; **Panel D:** Q4 – Table 2; **Panel E:** Q17, Q18, Q19 and Q20 – Table 2.

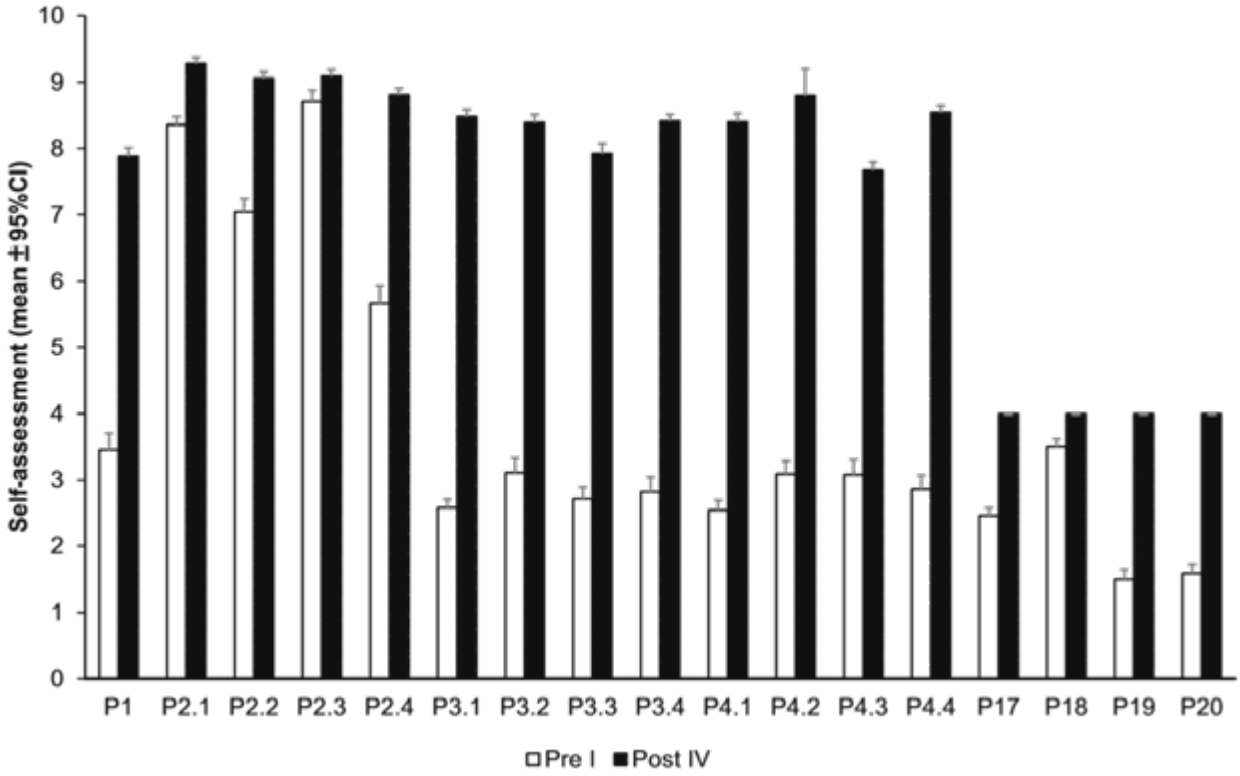

FIGURE 4. Global evolution of the simulation modules. Mean ± 95% CI.

muscular blocking did not change with the module, nor did all questions of panel E, regarding the importance of simulation. In response to these questions, all students agreed on the high impact and importance of simulation.

Comparisons between self-assessment of each post-module questionnaire with the pre-module of the following year were also performed to address the learning during residency (post-pre analysis). Comparing post-Year I with pre-Year II, the preparedness for critical events increased (panel A). However, the importance attributed to critical points in Anaesthesiology decreased (panel B). Regarding panel C, the evolution showed a marked increase in the training in difficult airway, contrary to the management of critical events that decreased from post-Year I to pre-Year II. All other comparisons showed statistically significant differences, except for the evaluations concerning training for emergencies in clinical practice and the perceived impact of simulation training on patients' clinical outcomes.

When comparing post-Year II with pre-Year III, the evolution is mainly positive except for the preparation for critical events, the training about ALS, emergencies in the clinical practice, and critical events management, which decreased. This is also accompanied by a decrease in the experience of emergencies in clinical practice and critical events management. The same pattern was found in the comparison between post-Year III and pre-Year IV.

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

GLOBAL EVOLUTION

Fig. 4 shows the global evolution of the simulation modules. All trends are positive, apart from Q3.3 regarding the importance of cardiac monitoring, which was already high before the first-year simulation module and therefore, the difference for the post-fourth year evaluation was not significant

DISCUSSION

Our study demonstrates that, across all simulation modules delivered throughout each year of the Anaesthesiology residency, self-assessed learning and competency development showed consistent improvement. Notably, in the first year, the difference between pre- and post-module self-assessments regarding the perceived value of simulation was several-fold, indicating a substantial initial impact. In the remaining years,

the differences were not so pronounced. Respecting the results of the self-assessment learning between simulation modules, there was an overall drop from post- simulation assessment in the previous year, compared with the pre-simulation assessment of the following year. Finally, self-assessment of the simulation modules was positive for all the evaluated parameters, meaning that the self-perception of competence improved the key for any educational program. The unique exception is for the self-assessment of the importance of cardiac monitoring that was as high at the beginning of the simulation modules 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 who were in a constant learning process, according to the pedagogical content of each year.

In Portugal, Anaesthesiology is considered an optional subject in most medical schools. Therefore, in most cases, residents have their first meaningful contact with this medical specialty and its various components during postgraduate training. This helps to explain the findings in our study, which demonstrate that simulation had a significantly greater impact in the first year compared to subsequent years.

The variations observed in the knowledge acquisition process across different modules suggest that residents progressed along Dreyfus' model of skill acquisition, moving from unconscious incompetence to conscious incompetence.[18] This shift is likely related to the increasing clinical experience and growing self-awareness of Anaesthesiology residents during each specific year of training. Furthermore, some loss or dilution of previously acquired concepts over time may also influence their self-evaluations.

During the first-Year, residents reported increased confidence in technical skills such as airway management, ventilation, cardiovascular support, and neuromuscular blockade, as well as in understanding their importance within Anaesthesiology. Although there was a slight decrease between post-Year I and pre-Year II, the values stabilized after post-Year II until the end of the study. Nevertheless, and besides this knowledge, the knowledge/awareness process fluctuations were much more marked, except for ALS, which stabilized after pre-Year II. ALS is the standard ERC ALS training and 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 ALS is well documented; when combined with traditional medical training, it has shown promising results compared with traditional education.[19] Furthermore, it should be noted that 26% of the questionnaires were completed by residents with an ALS background, which constitutes a valuable complement to their training.

The changes observed in training on difficult airway management appeared paradoxical: after a marked increase from post-Year I to pre-Year II, there was a notable decline during Year II. The initial increase suggests that residents had substantial exposure to airway management during their first year of residency and perceived themselves as having achieved a high level of competence in this skill. However, during the Year II simulation module, when specific training in the management of difficult airways was delivered, residents became aware of a critical gap in their competence in this area. Notwithstanding, the experience regarding difficult airway management stabilized after post-Year II until the end of the program with a slight decrease between post-Year III and pre-Year IV, again demonstrating the gain of awareness at different timings of the training process and a loss of concepts throughout the year.

This is of paramount importance since airway management is a cornerstone in Anaesthesiology, emergency, and critical care medicine that can have a considerable impact on patient safety.[4,8,20-22]

Emergencies and critical events management simulation belong to last year module, which may explain the variations found not only in training but also in the experience. Each simulation module, as demonstrated by pre- and post-module comparisons, had a positive impact on training and experience in the management of emergencies and critical events. Nevertheless, in the intervals between modules (post-to-pre comparisons), average self-assessment scores declined. This suggests that, over the course of years, residents develop greater self-awareness and insight into their training, including recognition of existing performance gaps.

This was also demonstrated regarding their preparation for critical events: until post-Year II, residents perceived an increase and stabilization (pre II-post II) on their preparation in critical events management. However, after that, variations occur, and although the preparation increased during the simulation module, it decreased between consecutive simulation modules. 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.[23,24]

It was somewhat unexpected to find that the perception about the positive effect of simulation in team training was relatively low initially, increased after post Year I, and stabilized after that. The same pattern was verified in the importance attributed to team simulation training in the clinical evolution of patients. Team training is crucial in the context of anaesthesia 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.[20] Moreover, Anaesthesiology is the specialty most frequently confronted with airway-related critical events in the emergency department, operating theatre, and intensive care unit, underscoring the vital importance of effective teamwork.[23]

During residency, trainees are shaped into independent clinicians, and simulation increases the learning opportunities, sharing responsibility for patient safety, and overcoming communication barriers.[26] 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.[14] 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 teaching, research, or assessment methods.[27] The impact or benefit of simulation-based training should be rigorously assessed by research in its various dimensions.[27-30] One of the dimensions is the resident self-assessment 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 results of simulation training, in the context of residency, from the resident's 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 performance of the residents evaluated by the trainer. Finally, since only residents that voluntarily enrolled in the program were included, these residents are, a priori, more prone and willing to learn.

CONCLUSION

This study shows that a simulation program standardized according to the curricular objectives defined by the Portuguese Board of Anaesthesiology positively impacts the learning process of Anaesthesiology residents. Our findings also provide insight into the potential impact of simulation in medical education beyond the field of Anaesthesiology. A structured simulation programme, aligned with the learning objectives of each specialty, could positively influence both the training and professional behaviour of residents.

In the first year of residency, the impact of simulation was more pronounced than in subsequent years. Between simulation modules, there was a decline in self-assessed learning, which may be attributed to increased self-awareness and critical reflection on one's own competencies. Taken together, our findings support the establishment of a national programme designed to be accessible to all Anaesthesiology residents. Such a programme would enhance clinical performance, complement traditional education, and enable longitudinal follow-up of participants throughout the four years of training.

DECLARAÇÃO DE CONTRIBUIÇÃO /CONTRIBUTORSHIP STATEMENT

FMM, MRM, IM - Conceção, recolha de dados, análise estatística, interpretação de dados, preparação do manuscrito e revisão crítica

GN - Preparação do manuscrito e revisão crítica

Todos os autores aprovaram a versão final a ser publicada

FMM, MRM, IM - Design, Data collection, Statistical analysis, Interpretation of data, Preparation of manuscript and Critical review

GN -Preparation of manuscript and Critical review

All authors approved the final version to be published.

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PROTECTION OF HUMAN AND ANIMAL SUBJECTS: The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and those of the Code of Ethics of the World Medical Association (Declaration of Helsinki as revised in 2024).

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