Impact of a simulation-based training on the experience of the beginning of residency

Bénéfice d'une séance de simulation médicale sur le vécu du début d'internat en médecine interne

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A B S T R A C T

Introduction. – We aimed to evaluate the impact of an immersive simulation session on the experience of the beginning of residency.
Methods. – The interventional group consisted of newly recruited residents in 2019, who participated in the workshop presenting four emergency scenarios frequently encountered during night shifts; the control group comprised residents who had begun their internship in 2018, without having participated in the simulation workshop. The level of psychological stress and self-confidence were self-estimated in the simulation group before and immediately after the workshop. During the second semester of residency, stress, self-efficacy and anxiety were evaluated in both groups with the Perceived Stress Scale (PSS), General Self-efficacy Scale (GSES), and Generalized Anxiety Disorder-7 (GAD-7) scale.
Results. – In the second semester 2020, the PSS, GSES and GAD-7 were 20.71 ± 8.15 and 22.44 ± 5.68 ($P = 0.40$); 26.88 ± 6.30 and 27.11 ± 3.95 ($P = 0.87$); 6.94 ± 5.25 and 8.89 ± 4.78 ($P = 0.22$) for the simulation ($n = 17$, 89.5% of participation) and control ($n = 9$, 75%) groups, respectively. In the simulation group, the level of self-confidence had significantly improved from 1.82 ± 0.95 before the session to 2.29 ± 1.16 after the session ($P = 0.05$). Interestingly, this improvement in self-confidence was significantly correlated with GAD-7 ($P = 0.014$) and PSS ($P = 0.05$), and tended to be correlated with GSES ($P = 0.09$).
Conclusion. – Our study showed a significant improvement in self-confidence between before and after the simulation session. Residents who experienced an improvement in self-confidence saw their stress and anxiety levels decrease during the second semester reevaluation, in favor of a prolonged benefit from the session.

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RÉSUMÉ

Introduction. – Nous avons cherché à évaluer le bénéfice d'une séance de simulation immersive sur le vécu d'internat en médecine interne.
Méthodes. – Le groupe interventionnel était composé d'internes, nouvellement recrutés en 2019, qui ont participé à l'atelier présentant quatre scénarios d'urgence fréquemment rencontrés lors des gardes de nuit ; le groupe témoin était composé de résidents ayant commencé leur internat en 2018, sans avoir participé à l'atelier de simulation. Le niveau de stress et de confiance en soi a été autoévalué dans le groupe simulation avant et après la session. Lors du second semestre d'internat, le stress, l'autoefficacité et l'anxiété ont été évalués dans les deux groupes à l'aide de la *Perceived Stress Scale* (PSS), de la *General Self-Efficacy Scale* (GSES) et de l'échelle *Generalized Anxiety Disorder-7* (GAD-7).
Résultats. – Au second semestre, la PSS, la GSES et le GAD-7 étaient respectivement de $20,71 \pm 8,15$ et $22,44 \pm 5,68$ ($p = 0,40$) ; $26,88 \pm 6,30$ et $27,11 \pm 3,95$ ($p = 0,87$) ; $6,94 \pm 5,25$ et $8,89 \pm 4,78$ ($p = 0,22$) pour les groupes simulation ($n = 17$, 89,5 % de participation) et contrôle ($n = 9$, 75 %). Dans le groupe simulation, le niveau de confiance en soi s'était significativement amélioré, passant de $1,82 \pm 0,95$ avant la session à $2,29 \pm 1,16$ après la session ($p = 0,05$). De manière intéressante, l'amélioration de la confiance en soi était significativement corrélée avec le GAD-7 ($p = 0,014$) et le PSS ($p = 0,05$), et avait tendance à être corrélée avec le GSES ($p = 0,09$).
Conclusion. – La simulation permet une amélioration de la confiance en soi, corrélée avec le stress et l'anxiété à distance, en faveur d'un bénéfice prolongé de la simulation.

Mots clés :
Enseignement par simulation
Internat
Médecine Interne
Stress
Anxiété

1. Introduction

Residency, especially in the early years with first night shifts, is known to be a difficult period in a physician's professional life, with higher levels of psychological stress [1], anxiety [2], and major depressive disorders (MDD) [3]. Burn-out is also prevalent [4], and seems to be associated with the presence of MDD, anxiety, and a reduced self-efficacy [2]. The latter has been defined by Bandura as a "belief in one's capabilities to mobilize the motivation, cognitive resources, and courses of action needed to meet given situational demands" [5]. Not surprisingly, a poorer mental state can lead to medical errors [6,7]. For instance, MDD among pediatric residents, increases by 6-fold the risk of self-assessed medical errors [8].

Healthcare simulation (HS) has been recognized as a means to achieve more knowledge and better procedural and behavioural skills than traditional theorical teaching methods [9,10]. Its uses range from anaesthesiology, and intensive care [11,12], to emergency medicine [13,14], perinatality [15], and more recently in other technical specialties such as cardiology [16,17] and nephrology [18,19]. By contrast, this method is much less used in Internal Medicine, Allergology and Infectious Diseases (IM-A-ID), specialties that have a common learning base during the residency in France. Experiences from nursing schools have suggested that HS helps to reduce stress [20] and anxiety [21], and improves self-efficacy [22]. Such aspects are poorly studied among residents, especially in the early years of residency.

Our study aimed to evaluate the impact of an immersive simulation-based training session on the experience of first-year medical residents specializing in IM-A-ID. Secondary objectives were to gauge the participants' opinion on the relevance of HS in the course of the residency medical training and its beneficial effects on day-to-day patient management.

2. Methods

2.1. Study population

The interventional group of this prospective study consisted of newly recruited residents in IM-A-ID from three French university hospitals, Montpellier, Bordeaux and Nice, in the fall of 2019 (respectively 9, 6 and 4 residents). All residents had just started their first year and all participated in the simulation session. The control group comprised of residents from the same cities except Bordeaux, who had begun their internship in 2018, without having participated in the simulation workshop.

2.2. Simulation workshop

In France, the residency is composed of 8 to 10 internships of 6 months each. This simulation workshop took place, in each participating city, during the first semester of residency in November, 2019. It was carried out over half a day, using a SimMan 3G® high-fidelity manikin, driven by Laerdal® software. The session consisted of 4 different scenarios recreating frequent situations that a resident may encounter during night shifts (Fig. 1). For each scenario, one or two residents played the role of the intern on duty, and a facilitator played the role of the nurse who made the call about the patient. Each of them consisted of 3 phases: first the briefing (about 5 minutes), with presentation of the simulation rules, the manikin, and the clinical context of the scenario; then the simulation session itself (about 12 minutes), which was filmed and broadcast to the other residents in a separate room; and finally the debriefing which involved all the residents of the workshop (about 30 minutes). The latest is the most important part [23], allowing the learner to correct his or her errors through a reflexive approach, using the technique of the good judgment [24]. A scientific support based on the current recommendations was explained to the residents. In each city, the session was orchestrated by physicians trained in medical simulation and debriefing [25].

2.3. Data collection

A pre-simulation questionnaire was submitted to the simulation group, including an anonymous identification process, sociodemographic data, the level of stress and self-confidence self-estimated on Likert scales ranging from 0 to 5 (0 being the minimum level of stress or self-confidence, 5 being the maximum)
. A post-simulation questionnaire was given to them immediately after the session, including 20 items concerning their satisfaction with the session, their opinion on the relevance of the simulation in their specialist training (Likert scales), and then again a self-assessment of their level of stress and

	Summary	Expected actions
Scenario 1	A 76-year-old patient hospitalized for abdominal pain has significant rectorrhagia, in favor of upper digestive hemorrhage. He is anticoagulated for atrial fibrillation and has a history of gastric ulcer. Rapid progression to hypovolemic shock.	- Blood sample to check hemoglobin, INR, blood group and antiglobulin testing -IV vitamin K 10 mg -Proton pump inhibitors -Crystalloid fluid infusion -Advice the gastroenterologist -Advice the intensive care physician -Ask for O - packed red cell
Scenario 2	A 78-year-old woman, with ischemic heart disease, hospitalized for right pyelonephritis and acute renal failure, presents with acute respiratory distress because of an acute pulmonary edema. Evolution towards a cardio respiratory arrest.	-Half-sitting position -Oxygen therapy -IV arterial vasodilator -IV diuretics -Advice the intensive care physician -Cardiopulmonary resuscitation
Scenario 3	A 65-year-old patient hospitalized for acute obstructive renal failure, awaiting surgical management, had a fever, tremor, then hypotension, whom diagnosis is septic shock on obstructive pyelonephritis.	-Crystalloid fluid infusion -Perform cytobacteriological urinary analysis and hemocultures -Empiric antibiotic therapy with third generation cephalosporin -Add Amikacin when faced to hypotension - Advice the intensive care physician -Advice the urologist
Scenario 4	A 55-year-old man hospitalized with pneumonia, presents with dyspnea and nausea after antibiotic infusion, in favor of anaphylactic shock.	-IM Epinephrine -Advice the intensive care physician

Fig. 1. Scenarios used during the workshop. IV: intravenous; IM: intramuscular.

self-confidence . During their second semester of residency in 2020, a re-evaluation questionnaire was proposed to them, including a new evaluation of the relevance of simulation use and their satisfaction, their self-assessment of the improvement of their experience and their patients care, and then the following 3 scales to evaluate stress, self-efficacy and anxiety

. First, we used the Perceived Stress Scale (PSS) which is a 10-questions questionnaire, with a total score ranging from 0 to 40, 40 being the maximum level of stress. This scale is one of the most commonly used and recognized scales for stress quantification, validated in French version [26]. Second, we used the General self-efficacy scale (GSES), which is the most widely used general scale evaluating this parameter [27], in French [28]. It includes 10 statements attesting to the feeling of self-efficacy, giving a total of 10 to 40, 40 meaning a maximum feeling of self-efficacy. There is no threshold for these two scales from which to diagnose a state of stress or normal self-efficacy. Finally, we used the Generalized Anxiety Disorder-7 (GAD-7), a validated tool for screening for generalized anxiety [29], validated in French [30]. This scale consists of 7 items, leading to a total score between 0 and 21, 21 corresponding to maximum anxiety. For this tool, a meta-analysis identified that a score threshold greater than or equal to 8 was effective in identifying an anxiety disorder [31].

A questionnaire was sent to the control group them during their second semester, including socio-demographic data, and the PSS, GSES and GAD-7 scales .

All these data were collected via Google® form sent to the residents by email.

2.4. Statistics

The quantitative variables were expressed as a mean ± standard deviation and were compared using the Mann–Whitney *U*-test. Qualitative variables were expressed as proportions, which were compared using the Chi^2 test or the exact Fischer test. Correlation analyses of the improvement in stress and self-confidence between pre- and post-session and the GAD-7, PSS, and GSES scales were performed using a Spearman's test. The statistics were performed using IBM SPSS Statistics 25 software. The results were considered significant if $P \leq 0.05$. Residents from the simulation group who did not respond to the re-evaluation questionnaire were not included in the final analysis.

2.5. Ethics

All participants were informed of the confidential nature of the session and signed a written consent authorizing the use of their

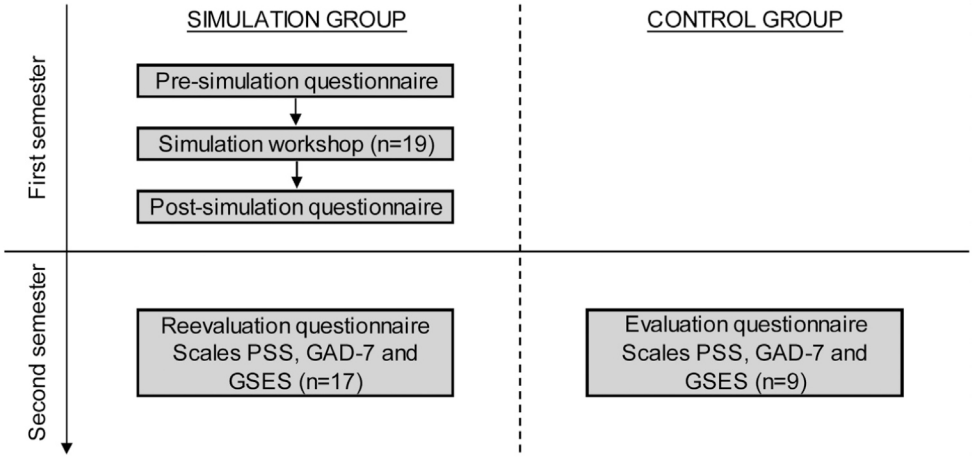

Fig. 2. Study design.

Fig. 3. Self-evaluation of the benefit of the simulation session on the experience of the beginning of the residency and the first night shifts, in the immediate post session and during the re-evaluation in the second semester.

anonymized data for educational research purposes. The Institutional Review Board (IRB) has agreed to this study, registered under the number 2019_IRB-MTP_11-29.

3. Results

3.1. Population

Of the 19 residents who participated in the workshop, 17 (89.5%) responded to the re-evaluation questionnaire and were included in the final analysis. In the control group, 9 of the 12 interns (75%) were included. There were respectively 52.9% and 77.8% women in the simulation and control groups (Fig. 2).

3.2. Main outcome

Whether in the immediate post session or during the re-evaluation questionnaire of the second semester, the self-evaluation of the residents concerning the benefit of this workshop on their experience improvement was very satisfactory (Fig. 3).

Based on the evaluation questionnaire in the second semester of residency, the PSS, GSES and GAD-7 were 20.71 ± 8.15 and 22.44 ± 5.68 ($P = 0.40$); 26.88 ± 6.30 and 27.11 ± 3.95 ($P = 0.87$); 6.94 ± 5.25 and 8.89 ± 4.78 ($P = 0.22$) for the simulation and control groups, respectively. Using the threshold of 8 for the GAD-7 scale, 35.3% of the residents were found to be anxious in the simulation group compared to 55.6% in the control group ($P = 0.32$) (Fig. 4). The level of self-confidence assessed by the Likert scale had significantly improved from 1.82 ± 0.95 before the session to 2.29 ± 1.16 after the session ($P = 0.05$). The self-estimated stress level had decreased from 3.71 ± 0.85 to 3.53 ± 0.80, although not reaching statistical significance ($P = 0.26$).

Interestingly, the improvement in self-confidence between pre and post workshop was significantly correlated with a decrease in GAD-7 ($P = 0.014$) and PSS ($P = 0.05$), and tended to be correlated with an increase in GSES ($P = 0.09$) in the second semester of residency.

3.3. Secondary outcomes

The level of satisfaction of the participants in the simulation session was excellent, with an overall rating given to the session of 4.82 ± 0.39, as well as an "evaluation of the interest of these simulation sessions in the context of preparing for the first night shifts" rated at 4.59 ± 0.71 on the re-evaluation questionnaire. Fig. 5 shows the details of the elements of satisfaction.

Overall, the residents considered simulation to be a very relevant educational tool in their specialty. In the post-session, they gave the proposal "Simulation has an interest in my specialty training" a mark of 4.82 ± 0.53, and they considered "it would be relevant to renew the simulation sessions" at 4.82 ± 0.39, all the residents having given this question a mark of 4/5 or 5/5.

In the second semester's re-evaluation questionnaire, the residents agreed with the statement "I think that this session enabled me to better care for my patients during the night shifts" at 3.82 ± 1.29; and with the statement "I feel that this session

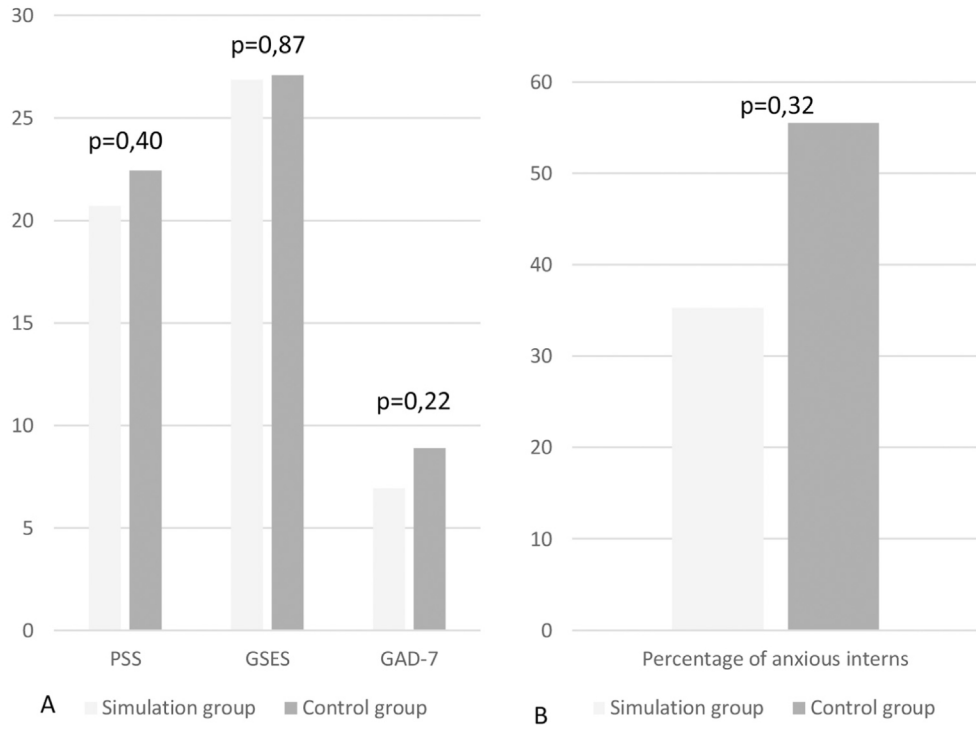

Fig. 4. Comparison of simulation and control groups. A: Comparison of the scales PSS, GSES, GAD-7. B: Comparison of the percentage of anxious residents screened with the GAD-7 scale.

provided me with skills that were useful to me during my first night shifts" at 3.88 ± 1.45.

4. Discussion

4.1. Benefit of the simulation on the experience of the first night shifts and the beginning of residency

Our study showed a significant improvement in self-confidence between before and after the simulation session, with a statistically significant correlation between this improvement, and stress and anxiety in the second semester. It therefore appears that those residents who derive an immediate benefit from the simulation session, with an improvement of their self-confidence, experience less stress and anxiety in the middle term. Their self-assessment of the improvement in their stress level as a result of the session was also very positive. An American study carried out on student nurses had revealed a significant benefit of simulation sessions on the anxiety felt before contact with the first patients, compared to a control group [32]. Similarly, a Canadian study showed that a procedural spinal tap simulation training session for pediatric residents improved their technical performance and decreased their anxiety, specifically for first-year residents. There was however no control group in this study [33]. Regarding psychological stress, a Taiwanese study of 31 newly graduated nurses randomized two groups, one with repeated simulation sessions for three months, the other with traditional teaching sequences. The simulation group had a significant increase in skills and self-confidence and a significant decrease in stress compared to the control group at the end of the 3 months [20].

Regarding the prolonged beneficial effect of immersive simulation observed in our study, it had been suggested that the multiple emotions present during a simulation session could explain this deeper anchoring of the messages transmitted [34], associated with the privileged supervision allowed by this particular framework.

In contrast to the literature [35,36], our study did not show any benefit of the simulation session on the improvement of self-efficacy compared to the control group. A meta-analysis had highlighted this benefit of simulation on the feeling of self-efficacy among young nurses, whether in pre/post session test comparison or in comparison with control groups [22]. There are several reasons that may explain this discrepancy with our study. First, there is the delay before the measurement of this parameter, which is further away from the simulation session than most other studies. In addition, we used a general self-efficacy scale, the GSES, which is validated, whereas most of the studies in the literature used either situation-specific scales, such as self-efficacy scales related to communication), allowing for greater sensitivity, or "home-made" scales created specifically for the study in question, which in our view may have less scientific value.

4.2. Interest of simulation in IM-A-ID

Learner satisfaction was excellent in our study, with a very favorable opinion of the residents regarding the relevance of this tool in their specialties. These specialties, less technical than others such as anesthesia or emergency medicine, make little use of simulation as a teaching method, especially in Europe. A similar study was conducted in Nancy, France, during which internal medicine residents were trained on procedural simulators in emergency and in routine internal medicine procedures, and in the management of acute dyspnea and acute purpura [37]. Other studies had used simulation as a teaching tool for medical students, using a standardized patient for instance with Raynaud's syndrome, highlighting the warning signs that lead to suspicion of secondary Raynaud's [38]. Similarly, another study had shown the positive impact of simulation sessions on the performance of preparation files for the French school-leaving examinations [39]. This tool could be used more in these specialties, for serious illness notification, emergency management training, as well as for learning of daily invasive procedures [40].

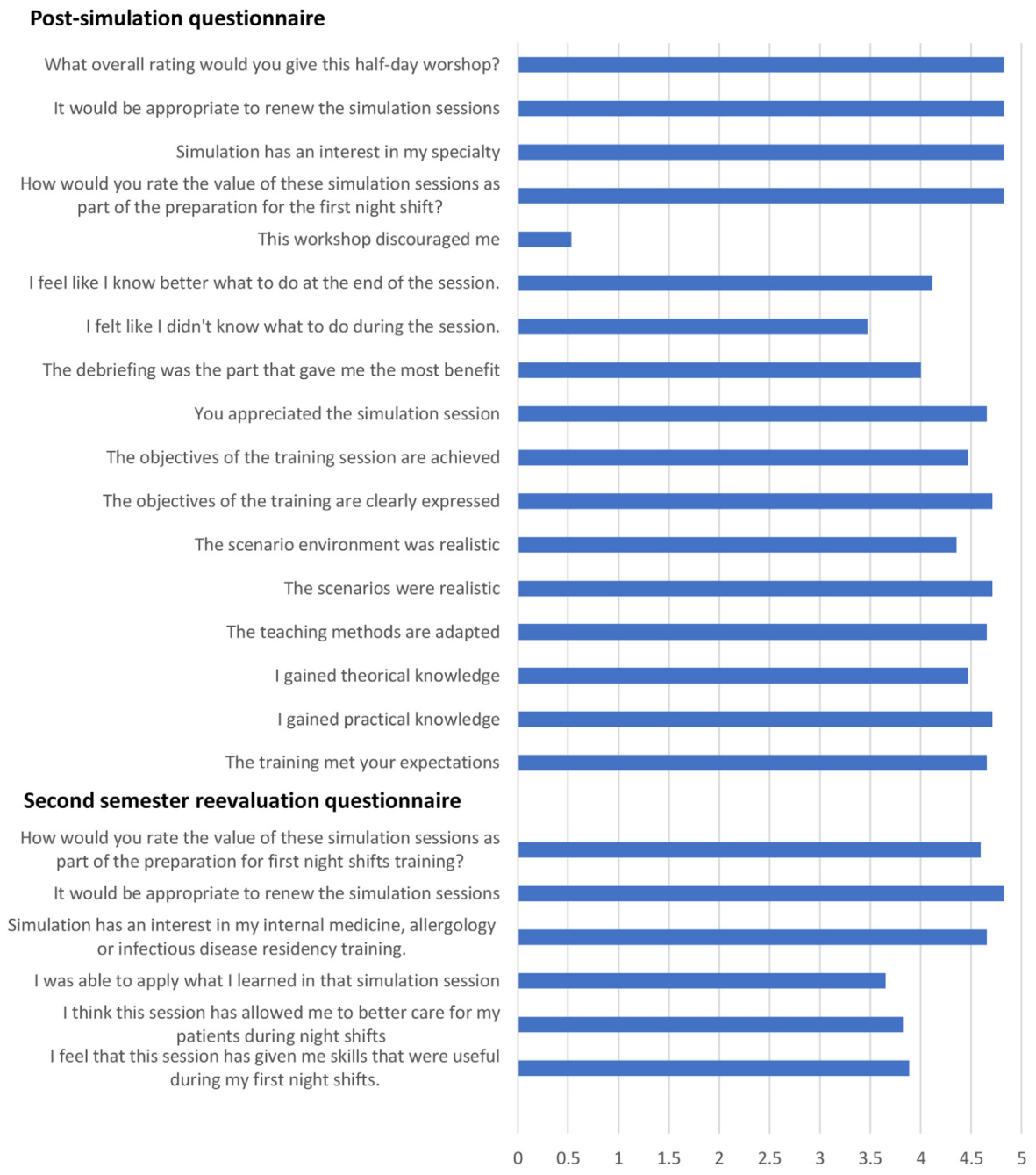

Fig. 5. Post-simulation questionnaire and reevaluation questionnaire in the second semester, of the simulation group, evaluating learner satisfaction, the interest of the simulation as an educational tool and its impact on patient management (Likert scales from 0 to 5).

This experience is an example of successful cooperation between several French centers regarding this promising pedagogical method. Its development on a national scale in a more homogeneous and systematic way could be an additional asset in these specialties.

4.3. Limitations and strengths of the study

Our study has some limitations. First, the number of participants was low, especially in the control group, which may explain why statistical significance was not achieved for several parameters. Second, the evaluation took place in the second semester, not immediately after the session, justified by our aim to assess the middle-term effect of this workshop, and not just the instantaneous effect. Moreover, the use of a control group tends to obtain a better level of evidence, but implies the risk of a loss of sensitivity for the demonstration of a significant difference between the two groups compared to a pre/post session test comparison design. In addition, the scenarios chosen were not specific to IM-A-ID. We chose these topics because these emergency situations seemed to be more stressful than, for example, a difficult diagnosis scenario. Therefore, simulation sessions with these scenarios, could be proposed to residents from other medical specialties. Finally, the occurrence of the COVID 19 outbreak during the first semester of the simulation group may have modified the experience of their night shifts compared to the control group. Nevertheless, one can imagine that if it had influenced the results, it would have been more with an increase in stress and anxiety in the simulation group.

On the contrary, our study has some strengths. Firstly, we used widely validated scales to assess the parameters of anxiety,

stress and self-efficacy. Second, we conducted this study using a control group and not just a pre-/post-session comparison. Moreover, the prospective temporality, and the multicentric design are major assets because the variability between trainers especially for debriefing is important. We also obtained a good level of participation in both groups. To our knowledge, this is the first controlled study showing the interest of simulation in the experience of the beginning of residency and the first night shifts, in these specialties.

To summarize, the realization of a simulation session for the preparation of first night shifts for IM-A-ID residents seems to have a positive impact on their experience. Residents who benefit immediately from the simulation session, with an improvement in their self-confidence, see their stress and anxiety levels decrease during the second semester's reevaluation, in favor of a prolonged benefit from the session. The integration of medical simulation in the training of residents therefore seems to be a method of interest, both to improve their experience and patients' management. Its development at the national level therefore seems important in the short-term.

Ethical approval

The Institutional Review Board (IRB) of Montpellier has agreed to this study, registered under the number 2019_IRB-MTP_11-29.

Disclosure of interest

The authors declare that they have no competing interest.

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