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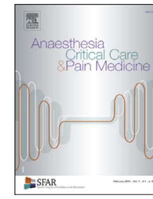

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Original article

Impact of learners' role (active participant-observer or observer only) on learning outcomes during high-fidelity simulation sessions in anaesthesia: A single center, prospective and randomised study

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ABSTRACT

Aim: The increasing use of high-fidelity simulation is limited by the imbalance between the growing number of students and the human resources available in such a way that all residents cannot play a role during scenarios. The learning outcomes of observers need to be studied.
Methods: This prospective randomised study was approved by the institutional review board. Anaesthesia residents attending a one-day training session were enrolled. In each of the four scenarios, three residents played an active role while others observed in a separate room. All participants attended debriefing sessions. Residents were randomised between active participant-observer group (AP-O group) and observer group (O group). A similar questionnaire was distributed before, immediately after the session and after three months and included self-reported assessment of satisfaction, medical knowledge (noted 0–16), and non-technical skills.
Results: A hundred and four questionnaires were analysed. Immediately after the simulation, a significant increase in medical knowledge was recorded but was higher in the AP-O group (6 [5–8] to 10 [8–11]/16) than in the O group (7 [5–8] to 9 [7–10]/16). High scores for non-technical skills were similarly observed in both groups. Satisfaction was high in both groups but was higher in the AP-O group (9 [8–9] versus 8 [8–9]/10, $P = 0.019$). Decay of knowledge was observed for most main outcomes at three months.
Conclusion: This study suggests an immediate improvement of learning outcomes for both roles after immersive simulation but some learning outcomes may be better for residents engaged as players in scenarios.

1. Introduction

The use of simulation in healthcare has been associated with both positive educational results including improved acquisition of knowledge, skills, behaviors and patient outcomes [1–2]. According to Kolb's experiential learning cycle, concrete experience is the basis for improved learning provided by high-fidelity simulation training [3]. Moreover, the theory of deliberate practice states that learners need to be active participants, to have repetitive practice and immediate informative feedback for effective learning to occur [4].

Due to the costs of simulation sessions and the imbalance between the number of students and the human resources available, all residents cannot play an active role during scenarios and several trainees remain observers during the whole session. As more learners are allocated to observer roles, there is an imperative to ensure that learning in this role is real and optimised.

The recent review by O'Regan *et al.* described the learning outcomes of observer roles and has suggested tools to improve this learning through the analysis of nine studies [5]. This review suggests that learning outcomes and satisfaction of observers may be improved with learner engagement. Few studies have however, analysed the impact of the learner's role (active participant or observer) on various learning outcomes (Kirkpatrick level 1, 2 and 3) during high-fidelity simulation sessions [5–9].

The recent study by Lai *et al.* has compared crisis resource management skills of emergency medicine residents during

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high-fidelity simulation sessions according to the status of learners (active participants or observers) and found that learning was not superior in active participants compared to observers [8]. A preliminary study done recently in our simulation centre has shown a similar improvement of medical knowledge whether learners acted as active participants or observers during scenarios [9]. In our study as in others, all learners participated to the debriefing part of the session. Limitations of our previous study included the fact that all participants were active in one of the four scenarios and that non-technical skills were not explored. Following our previous research, a second study was thus designed to explore the impact of learner's role (active participant – observer or observer only) on medical knowledge (Kirkpatrick level 2) immediately after high-fidelity simulation. Other learning outcomes (Kirkpatrick level 1, 2 and 3) as well as the 3-month retention of knowledge were also assessed.

2. Material and Methods

2.1. Inclusion and study design

The institutional review board of the French Society and Anaesthesia and Intensive Care Medicine (comité d'éthique pour la recherche en anesthésie et réanimation) approved this study (IRB 00010254-2016-053). This prospective randomised study was conducted at LabForSIMS (Paris Sud University, France) simulation centre (Clinical-trial.gov ID: NCT02804425). The simulation-based research extension for the CONSORT statement [10] and recommendations for reporting educational studies using the GREET checklist were used for reporting the study details [11].

All third to fourth-year anaesthesia residents of Paris were invited to attend a one-day training session, which included four different scenarios using a high-fidelity mannequin. This one-day simulation session was dedicated to scenarios of anaesthesia crisis resource management and the same design was used every day. All instructors were staff anaesthetists and had received formal and practical training in simulation education. Before starting the session, residents were informed with a briefing about educational objectives, rules and principles that guide simulation sessions and were familiarised with the simulation environment, including the technical features of the high-fidelity mannequin (SimMan 3G®, Norway, Laerdal). Four simulated crisis scenarios (cardiac arrest, local anaesthetic systemic toxicity, malignant hyperthermia and trauma-induced abdominal hemorrhage) were played and each was followed by a specific debriefing, which was attended by all learners. Each scenario had technical (medical guidelines) and non-technical (communication, team-working, call for help...) objectives.

The randomisation list was prepared by an associate clinical researcher who did not actively participate in the study and was available in an opaque envelope. After obtaining consent to study participation, the residents were randomised between active participant-observer group (active participant during one scenario and observer for the three others) (AP-O group) or observer group (observer during all four scenarios) (O group) (Fig. 1). Each day, three residents were allocated in each of the four scenarios and the list was given to the instructors. During each scenario, three residents played an active role while others observed the scene in a separate room using direct video recording and transmission. The two groups were unequal despite randomisation because 12 active participants per day were included, i.e. 60 residents were active participants and the others were observers along the five days of the training course. During each scenario, the three active participants played the role of anaesthesia resident, senior anaesthetist and healthcare professional called for help, respectively. Instructors played a role (surgeon, nurse...) to improve realism and facilitate the progress of the scenario if necessary. Participants were not informed of the scenarios and their role before the session.

Active participants were debriefed but observers also actively participated in debriefing and were encouraged to share their thoughts. Debriefing was done orally lasted $\geq$ 45 min and was not associated with any additional technical tool. It typically consisted of three phases: the first phase was aimed at receiving residents' reaction and emotional status, the second was an understanding phase with a reflective and informative feedback about the simulated experience and contextualisation in real life and finally the summary phase with key messages. During the understanding phase, technical and non-technical skills and behaviors (as described above) were discussed together. The instructors had a checklist of technical and non-technical skills objectives for each scenario. Debriefing implied an intermediate level of instructor involvement [12]. At the end, a paper abstract of medical guidelines was given to all participants.

2.2. Assessment of the learning outcomes

The learning process was explored by using the levels of learning described by Kirkpatrick [6]. The primary outcome measure was the assessment of medical knowledge (Kirkpatrick level 2) immediately after high-fidelity simulation. Medical knowledge and its changes were measured using the same questionnaire, which was addressed before and immediately at the end of the simulation day. A 16 multiple choice questionnaire (MCQ) was constructed by three instructors and included questions related to the simulated scenarios (noted 0–16) (4 questions per scenario). To the questionnaire were added questions unrelated to the training program, which were not computed for statistical analysis.

The other levels of learning were also explored as secondary outcomes.

Non-technical skills were recorded using a self-reported questionnaire immediately after the simulation session (Kirkpatrick level 2) with seventeen questions. This questionnaire, also constructed by the same three instructors, included items and categories all the sixteen items from the categories of non-technical skills used in the Anaesthetists' Non-Technical Skills (ANTS) tool (task management [4 items], team working [6 items], situation awareness [3 items], decision making [3 items]) [13] and one question about coping with stress. We chose the method used by Yee et al in which subscores obtained for each of the four skill categories are assessed [14]. Questions were each recorded using a 1 to 10 Likert scale and sub-scores were obtained by adding results of individual items questions in each skill ANTS category (median/10, interquartile range). The degree of satisfaction (i.e. Kirkpatrick level 1) was recorded immediately after the simulation session using a 1–10 Likert scale. The perceived transfer of learning was assessed using a 1 to 10 Likert scale (Kirkpatrick level 3).

The assessment of the 3-month retention of knowledge was also recorded. Questionnaires similar to those used on the day of training were sent using the list of email addresses to all participants 3 months after the simulation session. Because of the poor response rate to the initial message, a reminder was sent 2 weeks later.

2.3. Statistical analysis

The sample size was calculated to differentiate a difference of one point on the knowledge test between active participants (AP-O) and observers (O). Therefore, assuming a power of 0.9 and an alpha risk of 0.05 and using one tailed analysis, 39 trainees by group were needed. All third to fourth-year anaesthesia residents