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EDUCATION & TRAINING

Results of the Use of a Simulator for Training in Anesthesia and Regional Analgesia Guided by Ultrasound

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Abstract
Show the learning results obtained by a simulation tool used by students of an online course on anesthesia techniques and regional analgesia guided by ultrasound. A satisfaction survey generated with a form of Google Forms was carried out in September 2018 with 14 questions related to the quality, ease and capacity of the learning obtained after the use of the nerve blocks Simulator, which was firstly published on the first edition of the course for 34 students. An average of 7.3 attempts of resolution have been made per practice and per student in the simulator. The students are, in their immense majority, habitual users of the ICTs and 73% of them consider that their experience with the simulator has been satisfactory and that their learning has been favored by this fact. The authors have verified that the ultrasound simulator contributes to the learning of skills for the practice of nerve blocks and, furthermore, it helps to ensure that theoretical knowledge is carried out in a more productive and efficient way.

Keywords Medical simulation · Medical training · E-learning · Satisfaction survey · Ultrasound · Nerve block · Regional analgesia

Introduction

Advances in medicine in the last decade have led to the development of techniques and skills that require increasingly specialized training, which focuses both on the use of new technologies and on the acquisition of skills as quickly and accurately as possible. All this, supposes a great challenge for the training of the specialist doctor, to which is added the need for patient protection which are demanding more safety margins from the ethical and legal point of view. The high quality and safety training is, therefore, a requirement in medical training that will be maintained throughout the professional activity [1].

The term "simulation" refers to the method of modeling or creating a virtual reality to mimic an activity [2]. The concept is broad and can refer to technical and non-technical skills and knowledge. Medical simulation has become a real solution to the challenge of providing optimal training in the shortest time possible.

There is a significant amount of evidence in different specialties that show the potential advantages of simulation in relation to the improvement of learning over traditional teaching centered exclusively on the patient [3–5]. On the other hand, it provides the protected environment avoiding that the technical error can give rise to devastating results on the patient [6].

This work aims to show the results obtained by a simulation tool used by students of an online course on anesthesia and analgesia techniques guided by ultrasound.

This article is part of the Topical Collection on *Education & Training*

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Material and method

The simulator

The simulator of ultrasound blocks for analgesia and regional anesthesia designed is a tool generated for the training of the technique in the educational framework of an online University Course [7].

The simulator allows you to practice different procedures with different levels of difficulty. Specifically, 53 practices simulated and selected by experts that include regional anesthetic blocks of the upper limb (16), regional anesthetic locks of the lower limb (16), regional anesthetic blocks of the trunk (8), blockages of the anterior wall of the thorax (5) as well as regional analgesia in the treatment of pain (8). The tool is developed in computer languages applied to web pages, such as Javascript, css, html5.

All the practices consist of the 3 phases in which an ultrasound nerve block is divided:

1. Position of the transducer (or probe) of the ultrasound on the anatomy of the patient looking for the ultrasound image we want.
2. Location in the ultrasound of the structure (nerve, muscle or area) on which we want to perfuse the local anesthetic.
3. Access to the target with the blocking needle without affecting any critical anatomical structure.

Figure 1 shows a snapshot of the operation of the simulator and the objective of the skill to be trained: to recognize the different structures observed in ultrasound images during the practice of analgesic blocks, to reach the local anesthetic perfusion site without any structural collateral damage.

The satisfaction survey

To assess the usefulness of the simulator, a satisfaction survey was proposed to the 34 students of the course. It was indicated that said survey was not mandatory, but the recommendation to carry it out was added to improve the simulation tool.

From the Google Drive online file storage service, a shared form was generated through a link and published in front page news, warning several times of the importance of completing the survey. For this reason, anonymity has been guaranteed, but not the uniqueness of the response.

The questionnaire includes general questions about Internet and computer knowledge. Others referred to general purposes of simulation. Other questions are focus on the utility of the simulator offered and on the knowing acquired. In total, 14 questions were configured, leaving the last one to allow a brief description of possible modifications of the tool.

The data was analyzed from frequency and proportions distributions. The comparison of categorical variables was performed using the chi-square test and Fisher's exact test, as applicable.

A multivariate analysis was carried out by means of a simple correspondence analysis relating the user's profile and whether the simulator met the learning expectations.

Results

In Table 1, number of attempts made can be seen in the set of all procedures according to the level of difficulty and the percentage of passes for the total for each level of difficulty. It is observed that a total of 10,407 practice attempts have been made among the 34 students, from which it is obtained that, on average, each student has done the practices in the simulator 306 times, with 5.8 attempts per practice. If we consider only the 27 students who have successfully completed the course in 1 year, the average number of attempts is 385.4 per student, with a value of 7.3 attempts per student and practice.

Regarding the results of the satisfaction survey, a total of 26 responses were obtained.

The most noteworthy results show that 7.7% are experts, 38.5% are advanced users, 46.2% are average users and 7.7% are fair as computer user.

They were asked if they considered that simulation is a useful method for learning, considering 100% of the respondents who agreed or strongly agreed. Regarding the learning

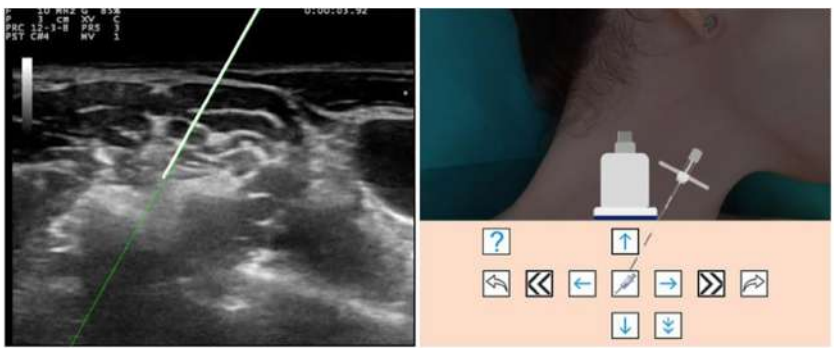

Fig. 1 Snapshot showing the practice of the skill on the ultrasound simulator

Table 1 Number of practices performed in the simulator by the total number of students, with result OK or Error and by level of difficulty

Result	Expert	Intermediate	Easy	Total
Error	1057	705	2236	3998
OK	2417	1865	2127	6409
Total	3474	2570	4363	10,407
% OK	69,57%	72,57%	48,75%	61,58%

expectations offered by the simulator, 61.5% considered that it had been fulfilled.

In relation to this question, they were asked if the way to use the simulator was dynamic. Only 1 respondent considers that its use and management is tedious (3.8%).

Figure 2 shows in a generic way if they defined the simulator as good or bad, and 66% consider it good or very good, although there is a percentage of 34% that thinks it can be improved.

After these questions of a general nature, they were asked in a more particular way about the acquisition of skills with the use of the simulator. In this case, for 92% of the respondents it was useful and allowed to acquire skills for the practice of nerve blocks through the use of ultrasound (Fig. 3).

In a complementary way, they were asked if, after using the simulator, both theoretical and practical knowledge had improved. In this case, of the 26 answers obtained, 20 were posited on the side of the Yes and 6 on the side of the little or nothing. In addition, 88% of respondents strongly agreed on the question of whether they had improved their theoretical knowledge, beyond the practical ones. They were also asked if they had integrated theory and practice with the help of the simulator (Fig. 4).

The last group of questions that were proposed to the students was about the future utility that the knowledge acquired with the use of the simulator could offer.

In our case, almost 35% of respondents considered it indifferent to have increased security and confidence after performing the practices with the simulator.

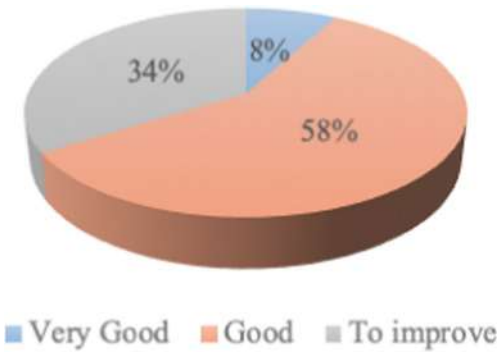

Fig. 2 Answers to the question: *How do you define the simulator?*

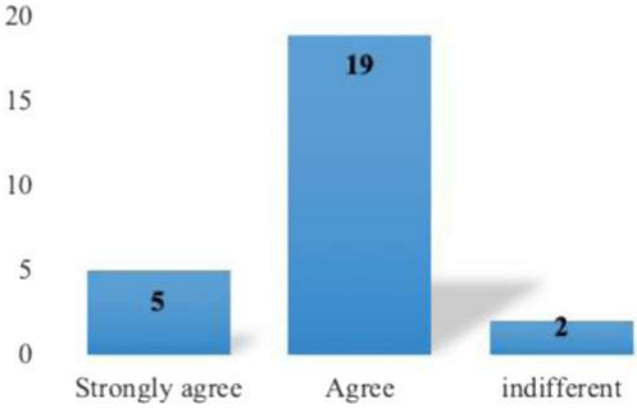

Fig. 3 Answers to the question: *Do you think that the design of the simulator helps the practice of ultrasound nerve blocks?*

In contrast to the above, only 11.5% considered that this simulation was not going to be useful in their future professional practice. In this sense, we think that is very possible that some of the students of this course do not have as primary objective the practice of the technique but only the theoretical knowledge because of its medical specialty.

Table 2 shows that 73% of respondents, the experience with the simulator has been at least satisfactory.

Finally, in the vast majority of the students surveyed who returned feedback, consider that the simulator is an added value to the course and would recommend it to other colleagues (Fig. 5).

Association between variables

The possibilities of association between variables were analyzed. Thus, when studying the association between the item: *Simulation is a useful teaching method for learning* with the item: *You consider that the design helps the practice of ultrasound blockages*, significant differences were found (p value = 0.001).

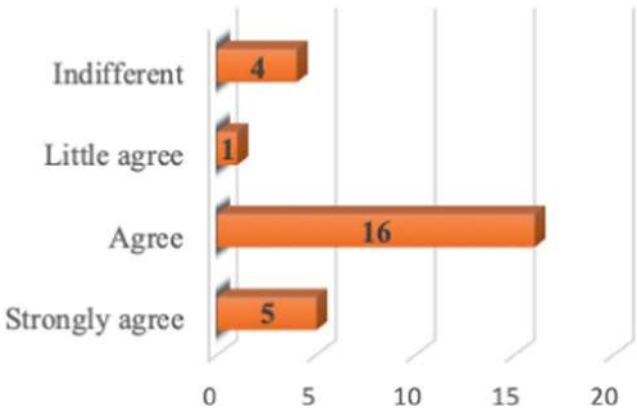

Fig. 4 *Has the simulation helped you integrate theory and practice?* 82% agree or strongly agree. 3.8% disagreed and almost 14% considered themselves indifferent

Table 2 The answers to the question are collected. *Has the experience with the simulator been satisfactory?*

Has the experience with the simulator been satisfactory?	n	%
Strongly agree	3	11,5
Agree	16	61,5
Little agree	3	11,5
Indifferent	4	15,4

There were also differences between the same item and the item: *Experience with the simulator has increased safety and confidence* (p value = 0.013) and with the item: *You consider that the design helps the practice of ultrasound guided nerve blocks* (p value = 0.001).

An association was found between *the computer user profile* and the item: *the simulator met your learning expectations* (p value = 0.003). Figure 6 shows the correspondence analysis between both items.

We found that there is proximity between advanced users and those who think that the simulator did not meet the learning expectations and on the other hand between the average user and those who think that the simulator met the learning expectations.

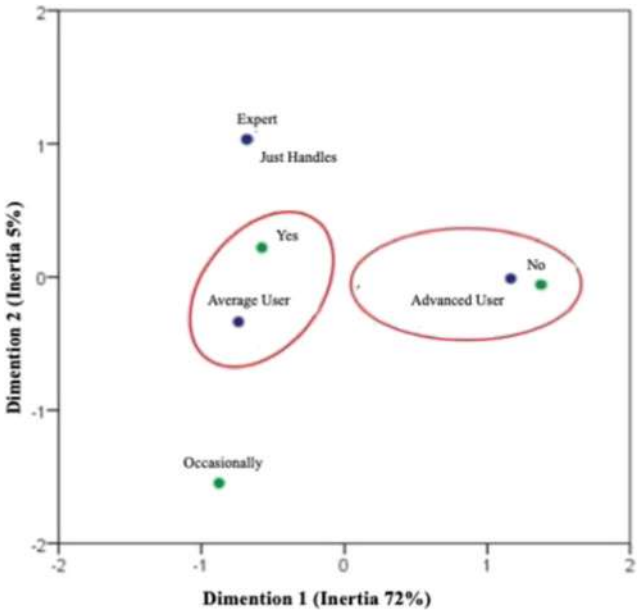

Fig. 6 Correspondent analysis between "user profile" and the statement "the simulator met the learning expectations"

Discussion

The simulation of clinical experiences is a set of methods that facilitate the acquisition of skills and abilities, in scenarios similar to real ones, without putting patients at risk. This form of learning is gaining ground in the training of doctors and health specialists [5–8]. The need to get a fast and specialized training together with the obligation to safeguard the safety and well-being of the patient make the clinical simulation an essential step before taking a new diagnostic or therapeutic procedure to the clinic [5, 9, 10].

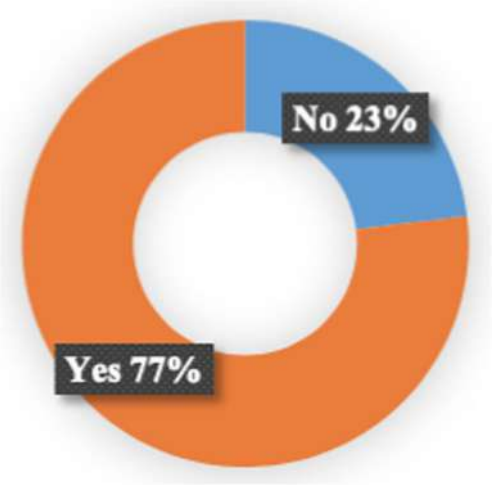

Fig. 5 Answers about whether they would recommend the completion of the course because of the simulator

These simulation models should be efficient learning tools regarding a surgical skill. To verify this, evaluation scales are used for the validation, in order to compare the performance before and after the practice with the simulators [6, 11]. In any case, today there is consensus to consider that clinical simulation is a tool to help learning and cannot replace traditional methods of learning such as training in the cadaver or patient-centered learning methods [6].

Our study shows, from the perspective of the student who practices with the ultrasound simulator, on the one hand, the satisfaction with this type of techniques in the teaching of medicine and on the other that it is a reliable and useful method for the development of skills. The high number of repetitions of each of the procedures ensures sufficient practice on the part of the students to reach the competence and be able to move to the subsequent clinical phase under supervision in the patient. All this, increases not only the safety of the patient at the time of the "learner" begins to apply the technique in the clinic, but also begins this clinical activity with much more confidence in itself. These aspects are confirmed in multiple publications on the advantages of medical simulation in clinical practice [12–14].

Another important aspect is that the tool not only serves to achieve practical ability, but also helps to understand the theoretical basis of the procedure, providing a more intuitive and effective learning based on a better approach to reality.

One of the great advantages of the tool is the simplicity of execution of the simulator and that it uses very basic resources for its development, that is, it only requires a system with a web browser and Internet connection. These aspects contrast with most of the simulation techniques whose main drawbacks are that they require high technical requirements or are expensive procedures [5, 7].

As limitations, the need to improve the technical aspects is emphasized, approaching the practice as much as possible to the reality of the patient. The requirement of the students is clear in this sense and, although they value the current tool, they do not fail to demand improvements especially in relation to accuracy or the need to perceive tactile sensations at the time of the puncture.

Finally, while accuracy is important in clinical procedures, it is important to note that local anesthetic volumes, neurotoxicity, and metabolic effects of underlying health conditions and surgical-related insults also contribute to clinical efficacy. Clinical measures such as motor responses, block character (duration and time), rescue block, and a myriad of other surrogate end points can be measured only in humans [15, 16].

Conclusion

The need to achieve a fast and specialized training in certain clinical skills together with the obligation to safeguard the safety of the patient make the clinical simulation an essential step before taking a new diagnostic or therapeutic procedure to the clinic. It cannot be forgotten that clinical simulation is a tool to help learn and cannot completely replace traditional methods of learning and training in the anatomy lab or the final development of learning skills in the patient.

In our study it was found that the ultrasound simulator contributes to the learning of skills for the practice of nerve blocks. On the other hand, it contributes to consolidate the theoretical knowledge that is carried out in a more productive and efficient way. However, there are still many aspects to improve with regard to the accuracy of the technique of insertion of the needle puncture and in need of professional perceive the touch sensation at the time of placing the needle correctly in the target.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent "Informed consent was obtained from all individual participants included in the study."

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