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ORIGINAL ARTICLE

A novel simulator model and standardized assessment tools for fine needle aspiration cytology training

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Objectives: Fine needle aspiration (FNA) is an invaluable diagnostic procedure for evaluation of lesions; however, acquisition of diagnostic material is dependent on the skill of the practitioner. We report a novel patient simulator for teaching the FNA procedure and structured assessment tools for educators and learners.

Methods: We created a novel simulator model for FNA training, employed a standardized teaching module, and assessed procedure utility in medical students. Groups of students completed training using a commercial version of the model, and underwent structured evaluation using an Objective Structured Assessment of Technical Skills (OSATS) form, and the Debriefing Assessment for Simulation in Healthcare (DASH) tool.

Results: In the initial phase, 178 students rated the training workshop between valuable and essential (4.2 on a 5-point Likert scale). In the second phase, for students evaluated with the OSATS form, the mean overall score was 33 out of 50 (range 26-43). The areas of weakness for the participants were: (a) compression after the FNA procedure, (b) completion of the informed consent, and (c) correct explanation of the procedure to the patient. For the group of students that completed the DASH questionnaire, the results were: 6.2 (assessment by students) and 6.7 (assessment by instructor) out of a maximum of 7.

Conclusion: A realistic simulation model, in combination with a standardized training program with formal assessment methods is a valuable tool to teach FNA. We here describe a process for teaching the FNA procedure to interested educators and learners.

KEYWORDS
cytology, fine needle aspiration, manikin, medical education, simulation

1 | INTRODUCTION

Fine needle aspiration (FNA) cytology is a diagnostic procedure with a long clinical investigative history, and although the basics of performing the procedure are the same, it has gained increased utility through the application of ancillary molecular techniques.[1] It is performed not only by pathologists, but also by trained physicians (eg, endocrinologists, gastroenterologists, internists, pulmonologists, radiologists, surgeons), via direct palpation or employing an ultrasound-guided approach. This procedure is important for rapid patient diagnosis and management; however, the efficacy of the procedure is only as good as the skill of the provider, emphasizing the importance of education in how to appropriately perform FNA biopsies. Best practices in medical education currently include incorporating of problem or team-based learning methodologies,[2] and adaptation to the latest generation of educational environments, such as online learning platforms with digitized images,[3–5] as well as training in clinical and technical skills. In this sense, many other disciplines have a long tradition in the field of simulation using tools adapted for these teaching requirements.[6–10] Medical students develop skills in suturing, cardiopulmonary resuscitation, intubation, or ultrasound techniques, which may be tested using the objective structured clinical examination (OSCE) or its variant, the objective structured assessment of technical skills (OSATS), developed at the University of Toronto in the 1990s.[11–15] However, to our knowledge, in the field of pathology and cytopathology there are very few references to medical simulation, including some preliminary results from our group and a liquid silicone-based approach.[16–18]

To date, a reproducible and standardized methodology for scenario-based teaching in palpation-guided FNA using a simulator has not been described or implemented. Previous studies have focused on ultrasound and endoscopic models, which even include virtual environments, although they are mostly directed toward resident physicians or the continuing education of specialists.[19–22] As such, they are not always adaptable for variable training environments from the practical point of view due to their complexity or their cost.[23] In addition, most of these teaching simulations are limited or unrealistic in regards to determining the adequacy of the sample, since the simple act of radiologically visualizing the needle inside a lesion is considered satisfactory for the purposes of these prior reports. In the reality of practice, as most cytopathologists are well aware, getting the needle into the lesion is only “half the battle” when attempting to obtain diagnostic material. Thus, these prior approaches represent an incomplete simulation as no simulated sample is obtained, nor is there opportunity for the learners to practice proper sample preparation (ie, expelling sample, making cytologic smears, rinsing the needle).

Herein, we report a standardized methodology to simulate the FNA procedure, developed over 5 years at our university hospital, which we believe can easily be extrapolated to a wide range of clinical teaching applications.

2 | MATERIALS AND METHODS

The study consisted of two phases, the initial phase of device creation and evaluation, and a structured evaluation phase. We created an anthropomorphic manikin for FNA puncture which was patented (WO/2016/185077 and WO/2017/109241), based on a system of lotion-filled balloons under a shell shaped like a human upper body, with holes covered with a silicone polymer that simulated the skin, through which the palpation and puncture was performed. During the initial phase, this handmade version of our model was tested during a 5 year evaluation period by more than 300 third-year medical students in our pathology course, who were presented with different clinical scenarios of possible target lesions (head and neck, breast, salivary gland, thyroid, lymphoid, and soft tissue cases). They received a brief introduction to the technique and its applications, followed by performing the procedure and obtaining a simulated sample. The students later completed a cytohistologic correlation using digital slides (40× whole slide images from conventional smears and tissue sections). Students were given an anonymous Likert scale questionnaire to evaluate the procedure, scored from 1 to 5 (1 = unnecessary/dispensable, 2 = little value, 3 = interesting, 4 = valuable, and 5 = essential).

In the structured evaluation phase, we implemented a commercial version of our model, FioNA (Sawbones, Pacific Research Laboratories, Inc., Vashon Island, WA, USA) and applied specific evaluation methodologies using either the modified OSATS checklist or the Debriefing Assessment for Simulation in Healthcare (DASH), for both the students and the evaluators. The commercialized version of the model had the technical advice of the inventor and, therefore, the major differences with the original prototype were based on greater durability and reusability, together with greater realism, with no significant differences from the practical point of view. Study participants consisted of a group of local and international students from the International Federation of Medical Students' Associations (IFMSA), originating from Egypt, Croatia, Poland, Portugal, Bulgaria, Greece, and Morocco. The training methodology consisted of a 3-hr workshop with an initial introduction to the FNA technique, followed by simulated clinical cases and hands-on performance of the procedure by the students. The FNA simulation station consisted of the manikin and everything else necessary to perform an FNA: gloves, alcohol and sterile gauze, syringes, needles, vacuum system (AspirGun or Cameco), and glass slides (Figure 1). In addition, the facilitator (E.A.) played the role of a patient during the exercise to give details of clinical presentation, and allow students to practice obtaining clinical history, explanation of the procedure, consent process, and examination.

Students were divided into two groups by availability: half of them were evaluated with OSATS and the other half with the DASH questionnaire following a debriefing. During the simulation, and with prior informed consent, the students evaluated with the OSATS form were recorded and/or photographed while accompanied by the instructor at all times, verifying and assessing achievement of objectives on the checklist, consisting of a total of 10 items evaluated on a 5-point Likert scale in a modified OSATS form (Table 1), with a maximum score of 50 points. Students were timed on the performance of the procedure. The last part of the workshop consisted of a debriefing, and, afterward, the completion of the DASH form by the students and the instructor.

Note: This educational project was exempt from ethical committee review as it was educational in nature and performed to evaluate the effectiveness of a new instructional technique. Furthermore, students gave informed consent for recording/photography.

FIGURE 1 FNA station

TABLE 1 OSATS form

	Item	Not performed	With difficulty		Performed easily	
1	Introduction to the patient	1	2	3	4	5
2	Clinical history (anticoagulant therapy)	1	2	3	4	5
3	Explanation of the procedure/sign the consent form	1	2	3	4	5
4	Asepsis/antisepsis	1	2	3	4	5
5	Palpation	1	2	3	4	5
6	Selection of the size of the needle	1	2	3	4	5
7	System assembly	1	2	3	4	5
8	Performance of aspiration	1	2	3	4	5
9	Compression	1	2	3	4	5
10	Performance of the smears	1	2	3	4	5

3 | RESULTS

During the initial phase, 178 students (from 2013 to 2015 academic years) were given the anonymous Likert scale (1-5 points) questionnaire, and they rated the workshop between valuable and essential (4.2).

In the second phase, 12 students were divided into two groups: 6 of them were evaluated with the OSATS form and 6 with the DASH questionnaire after a debriefing. For the students evaluated with the OSATS form, the following results were obtained: mean time (minutes: seconds) to perform the simulation: 09:54 (range: 07:35-14:10) and a mean overall score for the simulation of 33 out of 50 (range 26-43). The phases of compression after the FNA procedure (2.2), completion of the informed consent (2.3), correct explanation of the procedure to the patient (3), techniques of asepsis/antisepsis (3.2) and clinical history (anti-coagulant therapy) (3.2), were the weakest points identified, followed by the palpation (3.3), vacuum system assembly (3.5), smear preparation (3.5), performance of aspiration (3.8), while the choice of the appropriate needle was correct in all instances (5). Results from the other group of 6 students assessed with the DASH questionnaire was as follows: 6.2 (assessment by students) and 6.7 (assessment by instructor) out of a maximum of 7. None of the elements evaluated were given an average rating of less than 6, except for the instructor in the third element—organized framing of the debriefing—with a score of 5.75 (Table 2).

4 | DISCUSSION

Medical education is undergoing change and adapting to the new generations of medical students, often referred to as *millennials*. Teaching based on lectures, where the student is a "spectator," is transforming into active learning, for which this generation has expressed their preference.[24] This includes training in medical simulation, leaving behind Halsted´s model of "see one, do one, teach one," where patient safety was compromised,[25,26] and turning into "see one, simulate many, do one competently, and teach everyone."[27] The assessment of these competencies represents an integral part of medical education that measures the progress of students and documents the knowledge acquired. Therefore, we have developed a methodology in a systematic, efficient and feasible way to organize, teach and evaluate a common diagnostic procedure, such as FNA, for the undergraduate medical student, by way of simulation-based learning.

This teaching modality is easily applied to the postgraduate/residency period and fills a need in cytopathology education.[28] This type of education is termed simulation-augmented learning by Haji et al.[29] A competency evaluation scale or checklist is designed for the evaluation of these types of clinical skills with an important technical weighting (OSATS), with a set of specific and highly structured tasks that are identical for every student. It also combines the objectivity of a checklist (yes/no) with a subjective component of how each valued action is executed (Likert scale of 5 points).[30,31]

McGahie et al. have proposed 12 features and best practices of simulation-based medical education: (i) feedback; (ii) deliberate practice; (iii) curriculum integration; (iv) outcome measurement; (v) simulation fidelity; (vi) skill acquisition and maintenance; (vii) mastery learning; (viii) transfer to practice; (ix) team training; (x) high-stakes testing; (xi) instructor training, and (xii) educational and professional context.[32] Our proposed methodology incorporates to the extent possible these characteristics and best practices. *Feedback* is given both during the simulation and after it, making use of debriefing sessions. *Deliberate practice*, with highly motivated students and instructor, is integrated into the *curriculum*, within the context of the pathology course. *Outcome measurement* is based on observations of the learner's direct actions, with input from the evaluator when

TABLE 2 DASH results

	Overall ratings (simplified)	
DASH element	Students	Instructor
The instructor set the stage for an engaging learning experience	6.13	7
The instructor maintained an engaging context for learning	6.3	6.8
The instructor structured the debriefing in an organized way	6.04	5.75
The instructor provoked in-depth discussions that led students to reflect on their performances	6.43	6.6
The instructor identified what students did well or poorly—and why	6.17	7
The instructor helped students see how to improve or how to sustain good performance	6.16	7
Overall score	6.2	6.7

completing the checklist. *Simulation fidelity* is achieved by using an anthropomorphic manikin to achieve a multimodal simulation while putting the procedure into the context of clinical history with the instructor's participation. *Skills acquisition and maintenance* is the main objective, which is achieved through performing the procedure with guidance, with *mastery learning*, ensuring all students achieve the proposed objectives. Since our learners were undergraduate medical students, they were not able to immediately *transfer to practice*; however, *team training* was performed in the diagnostic correlation section. Since this technique was implemented as an OSCE station, the testing is by definition *high-stakes.* The *instructor*, a cytopathologist and the developer, was well-trained to facilitate, guide, and motivate the student. The *educational and professional context*, was covered by the integrated approach to individual clinical cases with subsequent diagnostic correlation using digital slide preparations.

The methodology developed by Brett-Fleegler et al.[33] was designed to help reflect on debriefing or to "debrief the debriefing" that, in turn and indirectly, analyzes the educational validity of a simulation program. It is an essential component of simulation training with a medical device, and it has come to be considered the most important point in simulation-based learning, where learners may critically appraise their own performance, investigate errors encountered during the simulation, and gain additional insights into ways to improve future performance.[34]

Like our colleagues of other fields, (eg, radiology), who propose integrating skills during medical student training period,[35,36] we intend to implement FNA simulation programs in the undergraduate medical curriculum, which not only provides the acquisition of useful skills and improve adaptation to current teaching methodologies, but also has the added value of highlighting and bringing the critical role of Pathology and the cytopathologist to the forefront.

CONFLICT OF INTEREST

Eduardo Alcaraz-Mateos is the inventor of patented models WO/2016/185077 and WO/2017/109241, together with the University of Murcia, Spain, and there is an agreement license with Sawbones (Pacific Research Laboratories, Inc., Vashon Island, WA, USA).

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