OBJECTIVES: The benefits of implementing point-of-care ultrasound (POCUS) in the emergency department are well established. Ideally, physicians should be taught POCUS during medical school. Several different courses have been designed for that purpose and have yielded good results. However, medical students need specifically designed courses that address the main objectives of knowledge acquisition and retention. Despite that, there is limited evidence to support knowledge retention, especially in the mid-term. The purpose of this study is to evaluate short- and mid-term knowledge retention after a student-aimed ultrasound course.

METHODS: Medical students participating in a medical student trauma symposium (SIMPALT) in 2017 were included. Their profiles and baseline ultrasound knowledge were assessed by a precourse questionnaire (PRT). The same questionnaire was used one week (1POT) and three months (3POT) after the course.

RESULTS: Most of the participants were 1st- to 4th- year medical students. None had prior ultrasound knowledge. They reported costs as the major barrier (65%) to enrollment in an ultrasound course. A comparison between the PRT and 1POT results showed a statistically significant difference ($p < 0.02$), while no difference was found between 1POT and 3POT ($p > 0.09$).

CONCLUSION: Our findings support the use of a tailored ultrasound course for medical students. Knowledge acquisition and mid-term retention may be achieved by this specific population.

KEYWORDS: Medical Education; Medical Student; Ultrasonography; Point-of-Care Technology.
The ultrasound course was one of the four skills stations of the symposium. The students were separated into four groups that rotated through the stations every 50 minutes.

The ultrasound course encompassed basic theoretical explanations of ultrasound physics, transducer choice, FAST systematization, E-FAST windows, and image interpretation. The theoretical session was followed by practical training in performing a FAST exam of a healthy volunteer. The course format was elaborated by one of the authors (CAMM). Every student received two questionnaires before the course. The first was intended to gather participants’ profile information and to determine what they considered barriers to enrolling in ultrasound courses. The second questionnaire (PRT) was composed of 8 multiple-choice theoretical questions, each of which had a unique correct answer, with the aim of assessing the students’ baseline knowledge. We excluded participants who did not answer both questionnaires from further evaluation.

Every student received the same questions one week (1POT) and three months (3POT) postcourse. Responses were compared between PRT and 1POT to evaluate knowledge acquisition and between 1POT and 3POT to evaluate knowledge retention in the mid-term. Students were also asked to grade the overall quality of the activity on a scale of 1 to 10.

We performed chi-square and Fisher’s exact tests using STATA software (STATA Corp. 2007. Stata Statistical Software: Release 10.0. College Station, Texas: Stata Corporation) to compare the responses. The confidence interval was 95%, and p-values <0.05 were considered statistically significant.

Results

This study was approved by the Institutional Ethics Committee and is reported according to the STROBE guidelines. Thirty-seven students answered the first two questionnaires and were eligible for inclusion. Table 1 presents the profile information of the included students and their responses regarding the main barriers to enrollment in an ultrasound course. The response rates for 1POT and 3POT were 49% and 32%, respectively. None of the students had participated in previous ultrasound courses. The mean course satisfaction score was 9.03 out of 10.

A comparison of the PRT and 1POT responses showed overall knowledge acquisition, which was statistically significant for 6 of the 8 questions (Table 2). A comparison between 1POT and 3POT revealed no significant difference despite a mild decrease in correct answers (Table 3). This finding was correlated with knowledge retention in the mid-term (3 months).

Discussion

The results of this study support the effectiveness and feasibility of a brief student-tailored ultrasound course. Comparisons of the answers to the questionnaires show acquisition and mid-term retention of knowledge.

The current study confirmed previous observations of the perceived barriers to ultrasound course enrollment. Financial investments, routine curricular activities, course location and time spent on the course were the main barriers. This brief course was also low-cost (less than US$ 30), included in symposium’s main scientific program, and performed at the same site. Hence, the main barriers were overcome.

Some studies evaluate factors associated with limited incorporation of POCUS. One of the most important factors is the lack of training (18,19). However, evidence regarding a specific analysis of barriers to course enrollment is lacking. This unexplored subject may undermine the development of newer educational platforms (20). Our study provides potentially useful results to enhance students’ participation in courses.

The optimal time to introduce POCUS concepts during medical education is still a matter of debate. The American Academy of Emergency Medicine advocates offering POCUS training to medical students (2,21,22). In fact, the incorporation of ultrasonography is well accepted among students who recognize various applications of that technology (15,23). Brunner et al. (24) in 1995, debated the introduction of ultrasound concepts to medical students by using echocardiography as an adjunct to the cardiology physiology course. The author demonstrated that echocardiography received the best rating among several topics of the course. This success may be related to a unique ability of ultrasound: increased integration of other subjects, such as anatomy, physiology, radiology, and surgery. FAST is an excellent example of such integration and is easily reproducible.

Studies have shown that medical students are capable of using ultrasound. In a study by Gogalniceanu et al., UK medical students demonstrated 88% accuracy in identifying free peritoneal fluid after a 5-hour POCUS course (18). Additionally, participants reported overall improvement of their knowledge regarding radiological anatomy and interest in further ultrasound training. They stressed the need to have this training widely available during medical school. Indeed, there are several benefits associated with such curriculum modifications. Barriers such as costs and the search for an adequate course would likely disappear. Additionally, ultrasound education for medical students would be homogeneous and standardized.

Several studies have analyzed knowledge acquisition by medical students after an ultrasound course. However, as noted in Table 4, none evaluated its retention in the mid- or long-term (20). Our results highlight the mid-term efficacy of a
short and straightforward ultrasound course. Another interesting finding of our study is that the majority of the participants were enrolled in the preclinical stages of medical education. This result supports the ability of students in the early phases of medical school to acquire and retain knowledge.

Limitations
The evaluation of knowledge based on theoretical questions, and no practical evaluation was performed. Hence, we could not assess mid-term knowledge retention in terms of actual performance of the exam. The participants’ response rate decreased during the study, and only 32% completed the 3POT questionnaire. This means that a potential significant difference may not have been detected and that there is a risk of selection bias. Moreover, we could not compare the results to a control group because every student participated in the course. Last, we did not determine whether the students had gathered information from other sources during the 3-month interval between the two questionnaires (1POT and 3POT), although this was unlikely.

CONCLUSION
This study makes two main contributions. First, a brief student-tailored ultrasound course results in knowledge acquisition and mid-term retention. Second, we demonstrated that costs, release from routine activities, location, and duration may undermine course enrollment. Factors impacting the dissemination and routine application of POCUS should be systematically assessed. The adoption of structured POCUS courses for medical students depends on a better understanding of the results of such training. We should make efforts to establish effective educational strategies to avoid potential barriers to course enrollment. Further prospective studies evaluating the impact of mid-term knowledge retention on the development of practical skills must be designed.

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AUTHOR CONTRIBUTIONS
Menegozzo CAM was responsible for the study design, data collection, literature review and manuscript writing. Cazolari PG was responsible for the data collection and manuscript writing. Novo FCF was responsible for the study design. Colleoni R was responsible for the critical final review of the manuscript. Utiyama EM was responsible for the critical final review of the manuscript.
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