Virtual Simulations to Enhance Medical Student Exposure to Management of Critically Ill Patients

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The management of critically ill patients is an essential skill for physicians practicing in the inpatient setting. The American Association of Medical Colleges (1) includes recognition, evaluation, and management of patients requiring urgent or emergent care as core entrustable professional activities for medical students. However, critical care experience remains variable across and within institutions (2). To address this inconsistency and ensure that students are prepared for residency, the Alliance for Academic Internal Medicine published recommendations for transition curricula and proposed that respiratory emergencies, rapid responses, and advanced cardiac life support should be taught via simulation (3). High-fidelity simulation is an effective method for teaching critical care skills (4), but broad implementation of in-person high-fidelity manikin-based simulation is limited by curricular time, physical space, faculty availability and expertise, and equipment costs (5). Virtual simulation presents a unique opportunity to overcome the barriers of traditional simulation modalities (6). To our knowledge, the use of a preexisting virtual simulation case library to teach critical care management has not been previously described. In this study, we implemented a screen-based virtual library of clinical emergency cases and assessed medical student impressions of this educational initiative.

METHODS

To expand opportunities to manage clinically decompensating patients, we piloted the use of two virtual medical

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Figure 1. Example of a virtual patient room from the Full Code platform. Students can interact with and manage the patient by clicking on a series of tabs and equipment in the virtual room to deliver care to the critically ill patient (7).

simulation cases for senior medical students completing an internal medicine transition to the residency course at the Perelman School of Medicine in March 2023. The 2-week course included lectures, small-group case-based discussions, standardized patient workshops, asynchronous virtual modules, and high-fidelity simulations. Learners were assigned two cases on a third-party virtual medical simulation platform (Full Code). The platform's cases were authored and peer-reviewed by a team of physicians employed by the software company and included relevant literature citations. Assigned cases were selected to complement in-person course content (small bowel obstruction and hyperkalemia with acute pulmonary edema). Participants also had the option of completing any of the 171 cross-specialty cases from the platform's library. Cases were completed on a website accessed through students' personal computers or cellular devices and did not require specialized software or equipment.

In the virtual simulations, students were required to obtain a focused history and physical examination and order relevant diagnostic and therapeutic interventions (Figure 1). After case completion, learners received an overall score based on the completion of anticipated critical and recommended actions, with deductions for unnecessary or harmful steps (Table 1). Feedback was also provided on differential diagnoses and planned disposition. Course faculty members had access to a dashboard of summative and individual learner performance; however, learner performance did not impact course grades.

After each case, students were asked to complete a six-question survey (*see* data supplement) to assess impressions of the assigned cases and platform. Four responses were recorded on a five-point Likert scale (from "strongly disagree" to "strongly agree") and two were free text. Students were also asked to complete an overall evaluation of the transition to the internal medicine course, which included

Table 1. Summary of Full Code platform checklist scoring items used to calculate the learner's overall score for the small bowel obstruction case

	Critical	Recommended
Review of systems	Gastrointestinal	Cardiovascular
		Respiratory
		Constitutional
		Genitourinary
Physical examination	Circulation	Pulmonary
	Abdominal	Back flank
	Genitourinary	
Stabilization	Insert IV catheter	–
	Attach monitor	
	IV fluid bolus	
	IV fluid infusion	
Investigations	Basic chemistry	Coagulation panel
	Complete blood count	Urinalysis
	Lipase	
	Liver function tests	
	CT of abdomen	
Interventions	Place nasogastric tube	–
	Pain control	
	Antiemetic agents	
Communication	Consult general surgery	–

Definition of abbreviations: CT = computed tomography; IV = intravenous.
Learners are provided a summative percentage score as well as a detailed outline of the total number of items performed that were deemed critical, recommended, unnecessary, or harmful.

ratings for individual curricular components (five-point Likert scale from 0 indicating "poor" to 4 indicating "excellent"). The study was deemed exempt from full review by the University of Pennsylvania Institutional Review Board.

RESULTS

A total of 30 students enrolled in the transition to residency course. Nineteen learners completed cases with capturable data from the virtual simulations, whereas data from the remaining 11 students were lost as a result of technical issues with platform registration. The number of individual responses to each survey question varied based on the student's completion of all questions. Students completed an average of 4.9 cases (range, 2–37), with 11 students choosing to complete extra, nonrequired cases.

The average critical action checklist–based score was 71.7%. In all, students completed a total of 51 simulations lasting 6.7 hours, spending an average of 22 minutes per simulation.

In the surveys administered after the cases, 77% of students (24 of 33 individual responses) agreed or strongly agreed that they felt more prepared to manage the scenario in real life and 79% (26 of 33 responses) indicated that the cases helped reinforce their knowledge of the diagnosis and management of the presentation. Of note, 42% of students (11 of 26 responses) agreed or strongly agreed that they were distracted by technical problems but unfortunately did not elaborate as to the nature of the issues experienced. Despite this, 75% (21 of 28 responses) agreed or strongly agreed that the cases were valuable. Overall course evaluations were completed by eight students. The virtual case sessions were rated at 3.00, which is similar to a standardized patient communication session (3.00; very good) and a Vital Talk communication simulation (3.00). However, the virtual cases were rated lower than the high-fidelity simulation sessions (4.00).

DISCUSSION

Virtual case simulations represent a flexible, scalable, less resource-intensive tool for learners to asynchronously and remotely practice and obtain immediate feedback on the management of decompensating patients. Although technical issues were noted by a significant number of students, the sessions were generally well received and scored comparably to other simulation modalities, with the exception of in-person high-fidelity simulations. Although high-fidelity simulations represent a valuable approach to teaching the management of critically ill patients, they remain a resource-intensive learning modality, which often limits their use. Virtual critical care simulations may be of particular value to more senior medical students looking for opportunities to practice more advanced, autonomous management of complex cases in decompensating patients, especially given the ability to access cases on demand and off site.

Given our small, single-school pilot program in a limited number of cases, future work is needed to understand the uptake, feasibility, and learner impressions of this technology across a broader sample of courses, learner levels, and institutions. We also recognize that our study did not assess the impact of this training on knowledge or behavior. It would be interesting to note if the perceived value of virtual simulation approaches that of in-person high-fidelity simulation as technical issues decrease with continued use. However, the ability of learners to access a robust peer-reviewed case library of critical care cases asynchronously presents a unique opportunity to expand the current footprint of critical care education across undergraduate medical education.

Author disclosures are available with the text of this article at www.atsjournals.org.

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