Launching resident-led simulations to augment the undergraduate medical school curriculum

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Abstract

There is good evidence for the benefits of simulation-based learning in medicine. However, difficulties with financing physician teachers and accessing simulation infrastructure are commonly cited barriers to simulation training. We developed a low-cost simulation program meant to augment early didactic teaching in the undergraduate medical curriculum with the help of residents as simulation teachers. Residents were provided with specially designed cases highlighting clinical aspects of recent curricular material. Residents were well suited for undergraduate teaching given the near-peer phenomenon. We described how our program could be replicated with minimal financial investment using a standard mannequin, a computer, and a supportive residency program.

Introduction

On the journey to become physicians, pre-clinical medical students around the world are taught foundational concepts primarily through didactic lectures and textbook readings. This learning environment offers limited opportunity to make clinical decisions or observe their impacts which, despite focused preparatory courses, can result in a jarring transition into clinical education.[1] Case-based learning (CBL) attempts to address this gap by presenting students with a text-based clinical scenario and a series of questions meant to build knowledge relevant to a real-world problem.[2] Unfortunately, a pre-written case offers no opportunity to interact with a patient, integrate physical examination skills, or make decisions which alter the course of the case. CBL is an excellent tool for helping students grasp new concepts, but it calls for a counterpart that allows students to bend, twist, and stretch their knowledge to make the decisions that will arise in clinical training. This counterpart is simulation-based learning.

Simulation-based learning strives to accurately imitate real world scenarios through deliberately planned problems which participants must solve in real time. Simulation training has been used in the aviation industry for years as a means of safely teaching trainees to deal with dangerous or uncommon situations. Within medical training, simulation plays the same role.[3] This teaching technique allows medical students to make clinical decisions and receive immediate feedback, while posing no risk to patients. Simulation has been shown to improve the utilization of treatment algorithms among medical students and residents.[4–6] Knowledge retention also increases from 20% in lectures alone, to 50% when knowledge is discussed (*e.g.*, in CBL), and up to 75% when knowledge is put into practice, as done in simulations.[7] In 2015, a systematic review and meta-analysis showed an improvement in patient safety when simulations were incorporated into medical training.[8] Even universal skills like leadership, teamwork, and communication have been shown to improve following simulation training.[9] So why is this valuable teaching technique not more prevalent in undergraduate medical curricula?

Although data are limited, the main barriers to simulation in pre-clinical training included limited faculty availability for teaching, limited financial resources, and student availability.[10] In 2018, our group of undergraduate medical students from the Island Medical Program at the University of British Columbia (UBC), in partnership with the University of Victoria, sought out to better prepare students for clinical medical education by launching an extracurricular simulation program. In the context of an undifferentiated patient presenting to the emergency department, we developed cases allowing students to use their history taking and physical examination skills to make clinical decisions. The simulated emergency room setting was felt to be most conducive for bridging the gap between pre-clinical and clinical training as students were able to investigate a complaint, establish a differential diagnosis, institute a treatment plan, and practice lifesaving procedures. The successes, challenges, and methodology of our program are discussed below, with the hope that it can be adopted in other undergraduate medical programs.

Residents as Teachers

Lacking the funds to hire faculty physician teachers, we opted to connect with residents and fourth-year medical students to host the simulations. We felt that this relationship could offer significant benefits to both the teachers and learners. Proficiency in teaching is a core objective in many residency programs.[11] Running simulations creates an opportunity to practice the art of teaching without the pressure of a waiting room full of patients. These opportunities may be particularly helpful for residents pursuing academic positions or fellowship training. Residents are valuable teachers because they bring the benefits of a "near peer" to the classroom. In addition to being more familiar with the knowledge base and comfort levels of medical students, having recently been in their position, residents are also perceived as more approachable.[12] We recognize that staff physicians would be more adept with the intricacies and advanced management of simulated topics. However, the goal of our simulations was to highlight core decision-making in the diagnosis and treatment of relatively common conditions.

We recruited teachers by emailing residents in the UBC Family Medicine, Internal Medicine, and Emergency Medicine residency programs in Victoria, BC. All residents participated voluntarily and simulations were scheduled around resident availability, typically after business hours. In cases where residents were unavailable, we

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Table 1 | Summary of simulation topics, content, and attendance

Simulation Theme	Core simulation concepts	University of British Columbia curriculum week pertaining to simulation	Attendance
Trauma, motor vehicle accident	Overview of primary survey, approach to shortness of breath, diagnosis and management of pneumothorax	Week 6 and 7 Pneumonia, cough, and COPD Week 10 Abdominal pain	6 Students 2 Teachers
Endocarditis	Chest pain differential, cardiac features, risk factors, cardiac workup	Week 66 Hypotension, Shock Week 56 Chest pain	4 Students 1 Teacher
Stroke	Neurological exam in unresponsive patient, assessing causes of stroke, altered level of consciousness differential	Week 22 Stroke	6 Students 1 Teacher
Arrhythmia	Chest pain differential, workup for abnormal ECG, treatment for common arrhythmias	Week 43 Arrhythmia Week 56 Chest pain	8 Students 2 Teachers
Syncope	Types of syncope, differential and workup for syncope	Week 8 Heart murmur Week 43 Arrhythmia	7 Students 2 Teachers
Head Injury	Initial management, disability assessment, sequelae of head trauma, imaging modalities to consider, interventions to reduce rising intracranial pressure	Week 20 Spinal cord injury Week 29 Head injury	4 Students 1 Teacher
Appendicitis, Abdominal Pain	Differential and workup for abdominal pain, physical exam findings in appendicitis, appropriate workup and management of abdominal pain	Week 10 Abdominal pain Week 12 Gastrointestinal bleeding Week 16 Pregnancy	5 Students 1 Teacher

recruited fourth-year medical students to run simulations. All teachers were given a curated list of simulation topics and asked to instruct only on the material that they were comfortable with.

Many of our teachers have hosted multiple simulations and expressed a desire to continue teaching undergraduate students. During our feedback sessions, teachers conveyed that running simulations was helpful for reinforcing their own knowledge base and building confidence with teaching. We recognize that residents are often busy with clinical duties and that relying solely on resident volunteers may not be sustainable. In the future, partnering with a residency program that has allocated time for residents to teach undergraduate students may foster a mutually beneficial relationship that provides medical programs with reliable access to near-peer teachers.

Materials and Methods

All simulations were held in the Royal Jubilee Hospital simulation lab in Victoria, BC. The simulation lab included specialty equipment such as high-fidelity mannequins, vital sign monitors, airway equipment, mock medications, and other equipment typically found in an emergency room resuscitation bay. The mannequin could produce physical exam findings such as peripheral pulses, respirations, pupil reactivity, abnormal chest sounds, and cyanosis. More advanced simulation equipment such as a defibrillator and an anesthesiology workstation were also available.

Each simulation was taught by a resident or fourth-year medical student who received a choice of case topics accompanied with learning goals, a case outline, and information about the knowledge level of their students. This ensured that students were not faced with clinical scenarios which they lacked the ability to solve. In the case of a chest pain simulation, students may have identified the need for an electrocardiogram, but lacked the training to interpret the results. Acknowledging this expected limitation, teachers volunteered the result of the test and offered a brief explanation of the diagnostic tool without delving into its intricacies.

Starting in October 2018, we hosted a simulation every four to six weeks over a ten-month period, covering seven different clinical themes (Table 1). Each session had eight to ten student participants and contained two to four related cases. At the start of each session, the teacher reviewed core principles relevant to the simulation with the student group, such as how to conduct a primary survey in trauma, the differential diagnosis for syncope, and imaging modalities in abdominal pain. The students were then split into four to six person teams and assigned roles—typically one physician leader, several nurses, and a recorder. Regardless of their role, all team members were encouraged to voice their ideas regarding the case. The teacher would present a clinical vignette with the patient's chief complaint and the team would proceed to take a history and physically examine the mannequin. The role of the teacher during the simulation was to help the case progress by answering history questions, adjusting the mannequin's behaviour, announcing positive or negative physical exam findings, and providing the results of investigations or interventions. The teacher was instructed to step in to redirect the group if they were unable to proceed or if they focused on a topic that was not central to the simulation. With the completion of each case, the teacher provided a resolution to the patient's hospitalization, debriefed with students, and addressed any remaining questions. Informal feedback was collected from the students and teachers for improving future sessions.

Looking Back

In reflecting on the feedback and experiences of the students and teachers involved, perhaps the most challenging component seemed to be molding simulations to simultaneously fit different knowledge levels. Our sessions were open to all medical students, meaning that some cases had first, second, and third-year students present. At times, senior students would dominate the case and bypass high yield learning points that would have been useful for junior students to reason through. Other times, senior students would become disengaged while the teacher reviewed core concepts. These issues can be avoided by limiting each simulation session to a particular year of training. If this is not possible, groups of mixed training levels may fare better if teachers encouraged the use of "time outs" or intermittently stepped

in to discuss the rationale around significant decision points.

We identified two common themes among the simulations which drew the most participants. The first was hosting simulations focusing on topics which students had recently covered in classes. The opportunity to apply newly acquired concepts and collect clinical pearls gave students the ability to prepare for both curricular exams and clinical practice. The second was advertising that procedural skills teaching would be incorporated into the simulation, for example, airway interventions, basic ultrasound, or cervical collar application. We believe that many students are aware of the utility of these skills and were eager to gain competence ahead of their clinical rotations.

We received strongly positive feedback from the students involved in our simulations. With student permission, we included some of the comments we received:

I found it interesting having the opportunity to apply what I learned in class to a clinical situation. It was also good to see some of the anesthesiology procedures being simulated before going on the wards. – Third-year student

You can get lost in the textbooks. The ER sim lab was a great change of pace. It was an exciting and fun way to learn. – Second-year student

The active nature of the sim lab was inspiring, refocusing, and fun; integrating and applying our learning while on the go consolidated it far better than simply hearing about it. – Second-year student

I felt like I was integrating and applying classroom learning in an engaging way that was preparing me for clerkship. – First-year student

Looking Forward

Our group is keen to continue providing medical students with simulation opportunities to augment their learning. The reason we have organized these simulations, and subsequently prepared this article, is because we believe that simulation-based learning should be regularly incorporated into every medical school's pre-clinical curriculum. Goolsby *et al.* showed that a single focused simulation training session was enough to impart medical students with confidence and knowledge that lasted throughout their emergency rotation.[13] A study surveying medical students after a similar simulation initiative found that participants valued the learning experience and benefited from the opportunity to apply knowledge and develop an approach to clinical problems.[14] Undergraduate medical programs lacking the resources to secure training equipment and teachers may overcome these barriers with improvisation. As described above, residents made for strong accessible teachers and likely derived benefit from hosting simulations. With the completion of an academic year's worth of simulation sessions, we will be connecting with the residency programs in Victoria in hopes of securing dedicated time for residents interested in simulation teaching.

Although we were fortunate to have an advanced simulation lab available to us at no cost, we seldom utilized the high-fidelity features or specialized training devices. Our most utilized simulation device, the adjustable vital sign monitor, can be replicated through a free program on a standard computer.[15] The physical exam findings produced by high-fidelity mannequins can be verbalized by teachers when students gesture toward a physical exam maneuver. We believe that the purpose of simulation in early medical training is to explore clinical reasoning rather than to perfect physical exam skills. We found that junior students would often become preoccupied by difficulties with interpreting simulated findings that were not central to the case. To mitigate this in future sessions, we may transition to completely verbalized physical exam findings.

A standard low-fidelity mannequin, a laptop computer, and a resident are the only resources required to bring simulation training to pre-clinical medical students. With the strategies outlined above, we believe that a comparable simulation experience can be created at most medical training programs with minimal financial expenditure.

Conclusion

We developed an extracurricular simulation training program aiming to supplement undergraduate curricular learning and prepare medical students for clinical training. This learning environment provided a safe opportunity for students to integrate concepts and practice clinical decision-making. Although residents made for effective teachers given the near-peer phenomenon, we recognize that relying on resident volunteers may not be sustainable at a larger scale. This issue may be mitigated by partnering with a residency program that offers dedicated time for teaching endeavors. Simulation organizers may also find improved student engagement if simulations cover recent curricular material, incorporate procedural skills, and limit participants to the same training level.

There is good evidence for the benefits of simulation training in medical education.[1-5,7,9,12] We suggested low cost alternatives to commonly cited barriers to simulation training in the form of standard mannequins, free digital resources, and resident simulation instructors. We hope that the experiences and methodology outlined in our paper can be used to bring simulation training to pre-clinical curriculums around the country.

Conflict of interest

The authors have declared no conflict of interest.

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