Validation of Homegrown Stethoscope Simulator for Cardiopulmonary Training

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

Original Research Article

ABSTRACT

Background: The education of health care professionals is a major contributor for patient safety. Advocates of simulation-based education, claim a particularly important role for this modality. Auscultation with stethoscope is an indispensable tool for optimal management of cardiopulmonary patients. However, the acquisition of sufficient training in cardiopulmonary auscultation is not straightforward because of the technical and ethical problems, I realized a low-cost stethoscope simulator to acquire and maintain the skill of cardiopulmonary auscultation. The aim of this study is to validate a homegrown stethoscope simulator for cardiopulmonary auscultation developed by the author and claimed to be of a low-cost and high-fidelity.

Materials and Methods: The hardware was built from a normal clinical stethoscope and a bluetooth headset, and the software is a single PowerPoint presentation slide with links to cardiopulmonary sounds' audio tracts. The stethoscope simulator was verified by the inventor, and a panel of experts was asked to evaluate its value as a training tool, relevance to practice, physical attributes, realism of experience, ability to perform tasks, realism of material" and realism of auscultation sounds. The validity of this homegrown stethoscope simulator was assessed by a panel of experts. The members had a session on the simulator and how it works, allowed to

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physically examine the stethoscope simulator, instructed on how to use it, and then auscultated all its cardiopulmonary sounds. A survey was provided to each member of the panel, and they were asked to rate their responses using a 5-point Likert scale as follows: strongly disagree (1), disagree (2), neutral (3), agree (4), and strongly agree (5).

Results: Experts in cardiology, respiratory medicine and respiratory care agreed upon the characteristics and attributes of this stethoscope simulator and the observed average of the "global assessment" of the stethoscope simulator was acceptable. The cost of fabrication of one simulator of this type was approximately 100 USD.

Conclusion: Primary evidence suggests that this homegrown stethoscope simulator is a useful tool that can be integrated into bedside teaching and clinical skill lab to facilitate teaching and learning cardiopulmonary auscultation for undergraduate learners.

1. INTRODUCTION

The education of health care providers is an integral part of patient safety. Advocates of simulation-based education claim a particularly important role for this modality [1]. Auscultation with stethoscope is an indispensable tool for optimal management of cardiopulmonary patients [2]. However, the acquisition of sufficient training in cardiopulmonary auscultation is not straightforward during undergraduate training, because of the technical and ethical problems and simulation is essential for improving both basic and advanced skills in a safe environment [3]. Moreover, the use of commercial stethoscope simulators is limited by their high cost. In order to overcome these limitations, I realized the need for a low-cost stethoscope simulator to acquire and maintain the basic skill in cardiopulmonary system assessment and the simulator was developed and verified [4]. The aim is to validate a low-cost and high-fidelity homegrown stethoscope simulator (Fig. 1) for cardiopulmonary auscultation developed by the author at Almaarefa Colleges for Science and Technology in the Kingdom of Saudi Arabia.

Fig. 1. Simulator hardware

2. MATERIALS AND METHODS

2.1 Hardware Construction

The stethoscope simulator was built using the components shown in Table 1. The hardware part was made of normal clinical stethoscope (MDF 747XP Acoustica Stethoscope by MDF instruments, USA) and commercially available wireless bluetooth head set device (by Platronics, China). The bluetooth head set was re-engineered so that it could fit in 4 mm diameter hole in the conducting tubes of the stethoscope (Fig. 1).

Table 1. Components used to build the hardware of the home grown stethoscope simulator and their cost

Component	Cost
Clinical stethoscope	$60
Bluetooth headset	$20
Bluetooth Headset Charger(3.5 Volts)	$10
Cutter	$5
Glue	$5
Total	$100

2.2 Software Preparation

The software is made up of a single slide of Microsoft PowerPoint presentation, this single slide presentation was carefully designed to work as computer human interface for the stethoscope simulator. The playable cardiopulmonary sounds' tracts in this software were selected from high quality recorded real human cardiopulmonary sound, which were tested and validated early during the project (Table 2).

2.3 Assessment of Simulator Validity

The validity of this homegrown stethoscope simulator was assessed by a panel of experts including 4 cardiologists, 8 respiratory physicians, and 18 respiratory therapists. The members had a session on the simulator and

how it works. Panel members were individually allowed to physically examine the stethoscope simulator, instructed on how to use it, and then auscultated all its cardiopulmonary sounds. A survey was provided to each members of the panel with following statements, and they were asked to rate their responses using a 5-point Likert scale as follows: strongly disagree (1), disagree (2), neutral (3), agree (4), and strongly agree (5).

1. This simulator is relevant to cardiopulmonary practice.
2. The experience I get from the simulator is similar to what I get from real patient.
3. With sufficient practice on this simulator, student will be able to identify those sounds in real life settings.
4. The sounds in this simulator are similar to those, I have auscultated in real-life patients.
5. This simulator is of value as a training tool for medical and respiratory care students.

Table 2. Simulator audio library

Cardiovascular	Pulmonary
Normal heart sound	Normal breathing sounds
Split 1st heart sound	Bronchial breathing
Split 2nd herat sound	Fine crackles
3rd heart sound	Coarse crackles
4th heart sound	Inspiratory strider
Systolic murmur	Wheezes
Diastolic murmur	Pleural rub
Opening snap	Pectriloquy
Gallop rhythm	Bronchophony

Their responses were recorded, and the means were calculated for each statement. Each panel member was also asked to provide open-ended comments regarding the realism of materials and physical attributes of the simulator.

3. RESULTS

The stethoscope simulator was verified by a group of expert physicians and respiratory therapists, and they agreed upon its characteristics and attributes. The observed average of the "global assessment" of the stethoscope simulator was acceptable. The cost of fabrication of one simulator of this type was approximately 100 USD. The panel agreed that this stethoscope simulator may allow medical and respiratory care students to perform cardiopulmonary auscultation in virtual reality with a high fidelity and at relatively low-cost.

4. DISCUSSION

Many stethoscope simulators are present in the market and have been used for long time in teaching clinical skills to medical and healthcare students [3], but our homegrown simulator is locally made, cost-effective and easy to operate. Experts reported high satisfaction with their experience using this stethoscope simulator and they agreed that this stethoscope simulator could be a useful healthcare simulation tool that can be integrated into bedside teaching and clinical skill lab to facilitate learning those important clinical skills. To my knowledge this is the first low-cost stethoscope simulator of its type.

There are several stethoscope simulators for training in auscultation skills in cardiopulmonary medicine, e.g. Sim Scope and Heart and Lungs Sounder. In comparison to other stethoscope simulators, the reported one is inexpensive and useful tool for easy training of auscultation skills in cardiopulmonary medicine, especially when there is limitation of resources. This study is unique because most of the similar simulators available in market were not scientifically validated [5].

Table 3. Expert panel survey results

Question	Mean
Simulator is relevant to cardiopulmonary practice.	5
Experience from this simulator is similar to what I get from real patient.	4
With sufficient practice on this simulator, student will be able to identify those sounds in real life settings.	4
Sounds in this simulator are similar to those, I have auscultated in real-life patients.	4
This simulator is of value as a training tool for medical and respiratory care students.	5
Overall result	4.4

5. CONCLUSION

Primary evidence suggests that this stethoscope simulator is a useful tool that can be integrated into bedside teaching and clinical skill lab to facilitate learning this important clinical skill. In the next step we will study its usefulness to student and whether it can be used with simulated patients (SPs) in hybrid simulation for teaching clinical skills and competency assessment.

CONSENT

 It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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