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ORIGINAL ARTICLE

Evaluating the baseline auscultation abilities of second-year chiropractic students using simulated patients and high-fidelity manikin simulators: A pilot study

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ABSTRACT

Objective: To assess the ability of 2nd-year students to identify normal and abnormal findings during cardiac and lung auscultation using high-fidelity manikin simulators and standardized patients. A secondary objective was to assess students' perceived competence and confidence in their abilities.

Methods: This was a descriptive pilot study of randomly selected 2nd-year students at 1 chiropractic training program. Participants were asked to perform cardiac and lung auscultation on high-fidelity manikins (2 stations) and standardized human patients (2 stations) with normal and abnormal auscultation sounds. Participants described the auscultated sound as "abnormal" or "normal" and were also asked to score their confidence in describing the sound and competence in performing auscultation on a 100-mm visual analog scale. Descriptive statistics were calculated for all study variables.

Results: Thirty-two students (23 women and 9 men) were included. For lung auscultation, 15.6% were incorrect on the human subject and 6.2% were incorrect on the manikin. For cardiac auscultation, 62.5% were incorrect on the human subject and 40.6% were incorrect on the manikin. Confidence mean scores ranged from 34.8 to 60. Competence mean scores ranged from 34.8 to 50.

Conclusion: Results identified that 2nd-year students from 1 institution were correct in identifying an abnormal sound during lung auscultation but reported low levels of perceived competence or confidence in their responses. They performed poorly on cardiac auscultation and reported low perceived confidence and competence in their abilities to perform cardiac auscultation and identify sounds.

Key Indexing Terms: Auscultation; Lung; Heart; Education; Manikins; Chiropractic

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INTRODUCTION

A competent physical examination is an integral component of a health care provider's ability to assess a patient and form a diagnosis or clinical impression. Thus, the ability to perform a competent physical examination is a focus of the educational curriculum for health care students. In addition to learning the psychomotor skills of performing a physical examination procedure, students must also develop the critical skill of interpreting physical examination findings and distinguishing between normal and abnormal results.[1–3]

Currently, there is a paucity of research regarding the evaluation of a student's ability to appropriately identify abnormal cardiac and lung sounds when performing auscultation in the context of chiropractic education. In addition, there is a paucity in the chiropractic literature of research assessing the use of auscultation and simulation in the education of diagnostic skills. As part of the curriculum at many chiropractic education institutions, students are taught to perform physical examinations, including auscultation of pulmonary and cardiac structures. The ability to perform a diagnostic test/procedure accurately and to interpret the findings is a critically important skill for a chiropractor to acquire.[1] The identification of an abnormal lung or cardiac sound by a chiropractor could warrant a contraindication to care, alteration of the patient's current plan of management, and even urgent referral of a patient to the emergency department.[4]

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In accordance with the Canadian Chiropractic Federation of Chiropractic Regulatory and Educational Accrediting Boards 2018 Standards for successful graduation from an accredited chiropractic program, students must "demonstrate proficiency in performing a physical examination," with the standards further noting that "the chiropractor also performs a basic evaluation of all body systems with the intent of screening for conditions that need to be considered in the differential diagnosis process or that require a referral to another health professional."[5]

A descriptive study conducted at a chiropractic teaching clinic identified that the thorax/chest was the third most common (14.1%) region of complaint for patients presenting to the clinic.[4] In addition, it is estimated that the prevalence of musculoskeletal chest pain in medical settings ranges from 20% to 50%.[6–10] It is therefore important for chiropractic students to be proficient not only in performing a diagnostic assessment of the musculoskeletal components of the thoracic region and chest but also in performing a nonmusculoskeletal diagnostic assessment of this region and accurately identifying abnormalities.

Several studies have identified poor and declining auscultation abilities in both physicians and medical students alike.[11–15] Research has also identified poor abilities in cardiac sound identification in internal medicine and family practice trainees and suggests a need for improved teaching and assessment methods.[16] It is important to identify whether chiropractic students also display these deficits and, if so, to identify strategies to improve learning experiences and outcomes. As primary care practitioners, chiropractors must be competent in assessing patients with a broad range of musculoskeletal and nonmusculoskeletal conditions.[16]

High-fidelity manikins may be an asset in assessing a chiropractic student's auscultation abilities. One group provided a model for cardiopulmonary manikin use and described it as the "missing link" in auscultation education.[17] The use of manikins can provide an important educational tool that bridges the gap between lecture and bedside treatment. Furthermore, numerous cardiopulmonary conditions can be presented through a single manikin. The ability to evaluate a multitude of conditions can provide students with a much more robust learning environment, closer to what would be encountered in a true clinical setting. Likewise, using manikins can significantly reduce the time and effort it would take to recruit actual patients with specific cardiopulmonary conditions.

Previous studies have provided support for the use of manikins for auscultation education.[18–25] It is thought that by contextualizing this education with manikin-simulated learning objectives, students can correlate audio knowledge acquisition with respective auscultation landmarks on the manikin; students can also better understand how sound may realistically radiate through a thorax.[18] This can provide a realistic experience that would not be available from audio instruction alone. At the time of preparing this article, manikins were not used in the education and/or assessment of auscultation skills at our institution.

The aim of this pilot research study was to assess the ability of 2nd-year chiropractic students at our institution to identify normal and abnormal findings during cardiac and lung auscultation using high-fidelity manikin simulators and standardized patients. The secondary aim of this pilot study was to assess students' perceived confidence in describing the sound and competence in performing auscultation.

METHODS

We conducted a descriptive pilot study of 2nd-year students at our institution in March 2019. Although a formal sample size calculation could not be carried out because of the paucity of research in this area, the investigators aimed for a sample size of 20% of the 2nd-year class to identify any significant issues with the methods and instruments of the study. It was also intended that this sample size would be adequate to inform future studies and potential curricular changes, if appropriate.[26] The primary investigator was responsible for participant recruitment, data collection, and obtaining participant consent. A random-number generator was used to randomly identify and invite participants. Selected participants were contacted via email and asked to voluntarily participate in the study. Participants were advised that refusal to participate in the study would have no effect on their academic endeavors and/or standing. Participants completed a consent form in person prior to participating in the study and were provided with a $10 gift card upon completion of the study as a token of thanks for their time. The study was approved by the Canadian Memorial Chiropractic College Research Ethics Board (No. 1901X01).

The study involved 4 stations, 2 involving cardiac auscultation and 2 involving lung auscultation. Participants were provided a total of 5 minutes to complete each station. The stations were as follows:

1. Manikin cardiac auscultation (abnormal sound; aortic regurgitation)
2. Standardized patient cardiac auscultation (normal sound)
3. Manikin lung auscultation (abnormal sound; crackles in the lower left lung field)
4. Standardized patient lung auscultation (normal sound)

The HAL S3000 life-size high-fidelity simulation manikin (Gaumard, Miami, FL, USA) was used for station 1, and the Susie S2000 life-size high-fidelity simulation manikin (Gaumard) was used for station 3. A 78-year-old man with no active/known cardiac pathology as confirmed by his medical doctor at the time of his most recent annual physical examination served as the standardized patient used at station 2 (cardiac auscultation), and a 30-year-old man with no active/known lung pathology as confirmed by his medical doctor at the time of his most recent annual physical examination served as the standardized patient at station 4 (lung auscultation).

For the cardiac auscultation stations (stations 1 and 2), participants were instructed as follows: "Perform seated

STATION 4: PATIENT LUNG AUSCULTATION

Instructions:

Perform posterior seated lung auscultation and answer the following questions.

1. **What type of sound did you hear? Please circle one of the following responses.**
   a. Abnormal Sound
   b. Normal sound

2. **Please place an "X" on the line below to rate <u>your feeling of CONFIDENCE</u> in your answer.**

Not Confident at All | **Completely Confident**

|____|

0 | 100

3. **Please place an "X" on the line below to rate <u>your feeling of COMPETENCE</u> in performing lung auscultation and answering the question.**

Not Competent at All | **Completely Competent**

|____|

0 | 100

Figure 1 - Example of a station outcome measure.

anterior cardiac auscultation and answer the following questions." For the lung auscultation stations (stations 3 and 4), participants were instructed as follows: "Perform posterior seated lung auscultation and answer the following questions." Participants were instructed to not communicate and/or to interact with the standardized patients and/or manikins at the stations for the duration of the study. Participants were provided with a clean and sterilized Littman stethoscope at the initiation of the study to be used by the same participant for the duration of the study.

Participants were asked to complete a paper-and-pencil questionnaire at each station (Fig. 1). Participants were asked to describe the auscultated sound as "abnormal" or "normal." They were also asked to score their confidence in describing the sound and competence in performing auscultation on a 100-mm visual analog scale (VAS). The 100-mm VAS has been considered both reliable and valid under a variety of conditions and has been used to evaluate change in confidence in prior studies.[27,28]

The following components were included in the questionnaire:

1. A question about the type of sound heard (abnormal vs normal)
2. A 100-mm VAS assessing confidence, ranging from 0 (*not confident at all in answer*) to 100 (*completely confident in answer*)
3. A 100-mm VAS assessing competence. From 0 (*not competent at all in performing auscultation*) to 100 (*completely competent in performing auscultation*)

All data were entered by the primary investigator into an electronic spreadsheet. The accuracy of the data was verified by completing double data entry by a second investigator. We computed descriptive statistics to describe our findings. Analysis was conducted using Statistical Analysis Software (SAS Institute Inc, Cary, NC, USA).

RESULTS

A total of 49 participants were contacted via email and asked to participate in the study. There was a total response rate of 87.8% (43 respondents); 7 participants declined to participate in the study with no reason provided, and 4 were unable to participate due to a conflict in scheduling. There was a nonresponse rate of 12.2% (6 nonrespondents: 3 female and 3 male participants). Thirty-two participants completed the study (23 women, 9 men).

Most participants (93.8%) were correct in identifying an abnormal sound during lung auscultation (Table 1). Participants also rated their confidence (60.0) and competence (49.9) highest during this task. Conversely, most of participants (62.5%) incorrectly identified a normal sound during cardiac auscultation. Participants rated their confidence (34.8) and competence (34.8) lowest during this task (Table 2).

Table 1 - Lung Auscultation Results

	Total Correct ($n = 32$)	Percentage Correct	Total Incorrect ($n = 32$)	Percentage Incorrect	Mean Confidence	SD	Mean Competence	SD
Station 3: manikin (abnormal sound)	30	93.8	2	6.2	60.0	26.9	49.9	25.6
Station 4: patient (normal sound)	27	84.4	5	15.6	42.4	27.5	44.6	25.8

DISCUSSION

As indicated above, the ability to perform and interpret the results of a physical examination is a critical component of a chiropractor's ability to assess a patient and form a diagnosis or clinical impression. Currently, research on education around auscultation has been focused on medical school students, nursing students, and physical therapy students, with a paucity of evidence identified regarding the education of chiropractic students.[1–3,7–9] Several of these studies have identified poor and declining auscultation skills in both primary health care practitioners as well as medical students.[4,6,7] It is imperative that if these deficits exist within chiropractic students, they are identified and improved upon.

The current study evaluated students in their 2nd year of a 4-year chiropractic program. At this point in their education, participants had received didactic education regarding the performance of cardiac and lung auscultatory skills as well as the interpretation of normal and abnormal findings. Participants had also completed laboratory sessions to practice psychomotor auscultation skills. In addition, they had also completed 2 simulation learning sessions using both the HAL and Susie life-size high-fidelity simulation manikins (Gaumard) described above, ensuring familiarity with these manikins. This study identified that while students were accurate in identifying normal and abnormal sounds during pulmonary auscultation (84.4% and 93.8% correct, respectively), they reported levels of competence or confidence in their responses poorly. In contrast, students were not accurate in identifying normal or abnormal sounds during cardiac auscultation (37.5% and 53.1% correct, respectively). Again, they rated their level or confidence and competence poorly.

Based on a review of several chiropractic educational programs, it appears typical that auscultation is taught and assessed formally at 1 point in a chiropractic curriculum; however, students may continue to practice this skill throughout their education. It also appears typical that chiropractic students will complete a practical/clinical component at the completion of their education, at which point it is likely they will perform and potentially be assessed on their performance of auscultatory skills and interpretation of findings. As such, it may be assumed that students have improved their proficiency as well as self-rated confidence and competence at the time of graduation. However, this cannot be ascertained based on the results of the current study. It may also be assumed that, as practitioners, chiropractors may frequently employ auscultation as part of a thorough clinical examination and thus may have further improved their proficiency and self-rated confidence and competence. However, the authors did not identify evidence to confirm or refute this assumption at the time of publication of this study.

Although the current study is preliminary in nature, the findings identified reinforce the need for educational methods that ensure students can accurately identify normal and abnormal findings during cardiac and lung auscultation. The use of high-fidelity manikins has been described as the "missing link" in cardiopulmonary auscultation education.[17] For example, a study by Perlini et al[17] assessed 532 third-year medical students, 92 fourth-year students, and 42 residents before and after a 10-hour teaching session with Harvey, a high-fidelity auscultation manikin (in addition to the standard curriculum). Prior to training, students were able to identify an average of 12.1% ($p < .001$) of 5 different cardiac diagnoses (atrial septal defect, normal young subject, mitral stenosis with tricuspid regurgitation, chronic mitral regurgitation, and pericarditis) selected from a pool of 50 diagnostic possibilities.[17] After training, the average score was 73.1%, and 3 years later (with no supplemental training), 68.4% of sounds were correctly identified ($p < 0.001$).[17]

Loftin et al[18] also used the Harvey manikin to compare simulation to traditional teaching methods. In doing so, they provided valuable insight into the educational methods that they used for cardiac auscultation instruction. Sixty-seven medical school students were divided into 2 groups. Students in group 1 attended a 20-minute classroom heart sounds activity using an instructor-developed PowerPoint audio presentation. The presentation included key words used to describe murmurs, physiologic descriptors of murmurs, and audio with animations of murmurs. The main presentation was led by an experienced instructor, and each audio clip was

Table 2 - Cardiac Auscultation Results

	Total Correct ($n = 32$)	Percentage Correct	Total Incorrect ($n = 32$)	Percentage Incorrect	Mean Confidence	SD	Mean Competence	SD
Station 1: manikin (abnormal sound)	19	59.4	13	40.6	46.6	29.9	40.3	27.6
Station 2: patient (normal sound)	12	37.5	20	62.5	34.8	27.6	34.8	24.1

played approximately 25 times. After the session, the students were given a multiple-choice quiz assessing their ability to identify abnormal heart sounds. Students in group 1 were then divided into smaller groups to take turns participating in a 20-minute tutorial on heart murmurs led by 2 trained clinical instructors. This session included demonstration of stethoscope placement of the following murmurs at all 4 cardiac points: mitral stenosis, ventricular septal defect, aortic regurgitation, mitral regurgitation, and aortic stenosis. Likert-type scale questions were administered after both the presentation and manikin training to assess confidence. Groups completed both forms of training, in reverse order, and answered the same set of questions. The study identified that both groups had improved confidence in learning abnormal heart sounds; however, the group that engaged in the heart sounds presentation followed by the simulation activity performed higher on murmur identification. It was concluded that cardiac auscultation institutions should consider the use of both classroom heart sound activities and simulation to improve student identification of sounds as well as confidence.

As indicated above, several studies have assessed knowledge acquisition using high-fidelity manikins.[17–25] Likewise, to evaluate the student's abilities to reach an accurate diagnosis, studies have also used both high-fidelity manikins and patients with cardiopulmonary diagnoses.[17–25] While increasing the exposure of students to patients and realistic clinical scenarios promotes the repetition of essential clinical skills, the use of high-fidelity manikins allows for the presentation of a wide variety of conditions, without the need for finding actual patients with relevant conditions. As technology advances, it is in the best interest of students and patients alike that academic institutions remain at the forefront of this advancement. Only through careful consideration and analysis can one determine the best methods of education. As outlined above, teaching sessions using a high-fidelity auscultation manikin (in addition to the standard curriculum), as well as the use of high-quality audio clips with animations of murmurs,[13,14] improved the interpretation of auscultatory findings in medical students and residents. Future studies would benefit from comparing different educational methods to determine if there is an optimal way to integrate technology into a chiropractic curriculum, in addition to using it for the purposes of assessment.

The current study used both high-fidelity manikins and simulated patients to evaluate chiropractic students' auscultatory abilities. It is relevant to note that for the study sample, high-fidelity manikins were not used during skill acquisition.

Based on the results of this study, in the context of the reviewed available evidence, the authors suggest that the integration of simulation technology into the current chiropractic curriculum has the potential to provide a profound impact on the ability of chiropractic students to perform auscultation and interpret auscultatory findings. Further study is needed to better understand the potential specific impact this might have on learning and assessment. However, adding a simulation component (using high-fidelity manikins or high-quality audio clips) to an established curriculum appears to be a helpful strategy, with no negative impacts identified during this pilot study. Based on a review of the relevant literature outlined above, the authors suggest that increased exposure to a variety of teaching and assessment methods throughout the educational process may result in improved skill and thus may possibly be extrapolated to improve the clinical skills of a future chiropractor. Again, future work would be helpful to confirm these hypotheses.

Limitations

It is relevant to note that this study involved a small convenience sample that may not be representative of the entire population of chiropractic students. It is important to interpret the results with caution. It is also important to consider the potential for skill development throughout the educational process, particularly through a practical/clinical internship. It is possible that auscultatory skills may improve over time; however, it is also possible that, over time, skills may decrease if not practiced. Future longitudinal research that evaluates changes over time in a more robust population may provide further insight into the role of teaching and learning auscultatory skills with high-fidelity manikins.

As a pilot study, the data collected provides relevant information to inform future research on both teaching methodology and assessment opportunities. It also allowed the authors to assess the feasibility of research methods for data collection that can be used for future research. Selection bias was reduced by using a random-number generator and randomly selecting students to participate, and future studies may implement similar strategies.

CONCLUSION

Second-year students at our institution demonstrated difficulty with identifying normal and abnormal cardiac sounds both with simulation manikins and patients. Students had increased accuracy with identifying normal and abnormal pulmonary sounds with simulation manikins and patients. In addition, students on average self-assessed their competence and confidence in auscultation for both cardiac and pulmonary sounds as poor.

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Author Contributions

Concept development: SDO, DS. Design: SDO, DS, DG. Supervision: SDO, DS, JT. Data collection/processing: SDO, DS, DG, JT. Analysis/interpretation: SDO, BS, JT. Literature search: SDO, JT. Writing: SDO, BS, JT. Critical review: SDO, DS, DG, JT, BS.

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