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ORIGINAL ARTICLE

A Comparison of Cardiac Auscultation Training among Undergraduate Students by use of Electronic and Wireless Stethoscopes

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ABSTARCT
Cardiac auscultation is a key skill for all physicians. The present study aimed at comparing the auscultation skills of medical undergraduate students using an electronic stethoscope and our proposed wireless stethoscopes. Students of University of Qazvin were randomized to use either the electronic stethoscope (group I) or wireless stethoscopes (group II) during a four month training period. A total of 48 students were enrolled in two groups. Students' auscultation skills were tested on patients at the university hospital. Each student completed a questionnaire (mainly multiple choice questions) on auscultation findings for each patient; then, total and average scores were obtained for each group and the derived data were subjected to t-test. Grading murmurs was performed in a better manner by electronic stethoscope (50.98% for electronic compared to 44.44% for wireless stethoscope). However, students using wireless stethoscope characterized murmurs more efficiently than those with electronic stethoscope (37.83% vs. 33.94%). In addition, false murmurs were reported more in the case of electronic education (10 vs. 9 of all 20 answers). The total score was a little more in wireless group than electronic group but no significant difference was detected (P>0.05). Although wireless stethoscopes suffer from the effect of noises which may cause more false reports, it is prioritized over electronic stethoscopes because it facilitates and accelerates education process and consequently, it may boost the number of true recognitions.
Keywords: *cardiac auscultation training, electronic stethoscope, wireless stethoscope, undergraduate students. Qazvin*

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INTRODUCTION

Auscultation of the heart remains an important examination for the detection of cardiovascular disease. The auscultator exam is expedient and cost effective. When completed by an experienced clinician, auscultation carries a high predictive value for identification of many-though not all-serious heart diseases. Definitive diagnosis may be possible by auscultation, as when classic murmurs of patent ductus arteriosus or mitral regurgitation are identified. Often the combination of signalment, cardiac and pulmonary auscultation, and general physical examination point to a tentative diagnosis. This presumption can then be confirmed, refined, or refuted by echocardiography (for valvular disease, pericardial disease, cardiomyopathy, or shunts) or by electrocardiography (for arrhythmias). The essential abnormalities of cardiac auscultation include: abnormal heart rate (bradycardia, tachycardia); irregular cardiac cadence or rhythm; abnormal intensity of heart sounds; extra heart sounds; absent sounds; split sounds; cardiac murmurs; and pericardial friction rubs [1,2].

Traditionally, cardiac auscultation has been taught best at the bedside during clinical undergraduate training and in preparation for postgraduate membership examinations. It is an essential component of the clinical examination, but like most clinical skills requires repetition and clinical experience to make an accurate diagnosis [3]. Indeed, prior to the advent of echocardiography, physicians were totally reliant on their stethoscope and auscultatory skills to accurately diagnose and characterize cardiac murmurs. The traditional clinical teacher will maintain that there is no substitute for clinical bedside teaching, while the modern educationalist will opt for multimedia applications, audio CDs and patient simulators [4]. We

would support the former, as evidenced by the decline in skills among medical graduates; cardiac auscultation, once the hallmark of an expert clinician, is rapidly becoming a lost art. The importance of cardiac auscultation cannot be underestimated and it remains an essential skill at the bedside, which, when performed well, can avoid the potential of 'over-investigating' patients and causing unnecessary anxiety. However, as many as three-quarters of American interns and two-thirds of cardiology trainees no longer receive formal teaching in cardiac auscultation. Several studies have reported an apparent lack of ability of interns to correctly diagnose a cardiac murmur [5].

The clinician must understand that many heart sounds fall below the frequency-threshold limit; accordingly, careful auscultation is necessary to detect the vibrations that are audible. Since advent of the first stethoscope by Laennec in 1816, several stethoscopes have been manufactured and marketed; electronic and wireless stethoscopes are of the most modern ones [6].

Electronic stethoscopes offer potential advantages compared to conventional pneumatic stethoscopes [7], and several of the features unique to electronic stethoscopes could influence the performance in cardiac auscultation [8]. The high sound quality, the possibility of applying personal adjustments to frequency [7] and volume, and education by simultaneous auscultation could improve the performance on a cardiac auscultation test. The volume regulator could also prove beneficial to students and doctors with organic hearing problems. Electronic stethoscopes are, however, sensitive to manipulation artifacts as well as electronic and ambient noise. The sound picture from an electronic stethoscope is also quite different from a conventional stethoscope, requiring training. Thus, some of the features could possibly influence the performance negatively. The volume adjuster is step-less, which could give rise to problems when grading the intensity of murmurs. The increased sensitivity to ambient noise and noise from handling of the stethoscope could increase the report of false murmurs, and lead to inaccurate characterization of murmurs [7].

Wireless stethoscope is very similar to electronic stethoscope; the main difference is in the method of final sound transmission to physician's ears. In wireless stethoscope, heart sound can be simultaneously heard by several physicians with approaching patients. However, wireless stethoscope may be prone to noises and consequently, false reports due to being wireless (depending on the method of wireless sound transmit). In the present study, "wireless digital stethoscope with special abilities"[p] was adopted which has been manufactured on the basis of sound transmission by analogous radio wireless with 434 MHz; this is not in the frequency range used for several medical equipment and that's why, its unwanted frequencies are eliminated through high pass and low pass filters. Therefore, heart sound is heard with the least change in quality in order to minimize the possibility of false report [3].

Considering what mentioned above, the present study was formulated to compare the auscultation skills of medical undergraduate students using an electronic stethoscope and our proposed wireless stethoscopes.

MATERIALS AND METHODS

The trial was conducted at Bu-Ali Hospital of Qazvin during the fall and winter 2012, using fourth year medical students at the University of Qazvin. Teaching groups, each comprising 6–8 students, were randomized to use either the electronic stethoscope (group I) or wireless stethoscopes (group II) during a four month training period. A total of 48 students were enrolled, 24 in each group. Furthermore, ten patients participated in the present study. The patients were subjected to cardiac auscultation practice by both groups.

The students at the University of Qazvin are introduced to cardiac auscultation during propaedeutic clinical courses in the third year, and more extensively during rotations in cardiology in the fourth year. In addition to the regular course program the students in our trial received a two hour lecture and four hours of clinical bedside teaching.

The students' auscultation skills were tested on patients at the university hospital. Each student completed a questionnaire (mainly multiple choice questions) on auscultation findings for each patient (table 1). Next to each patient was a brief survey of the patient's presenting complaints, and the patients were instructed not to reveal their diagnoses. The students were allotted ten minutes to examine each patient. They were alone with the patients during examination, and were instructed not to discuss their findings with any other student.

The correct answers on the questionnaire were defined by consensus of two cardiology consultants who examined the patients with acoustic stethoscopes on the same day as the students were tested. Each questionnaire was interpreted and scored blindly by one person. When there was doubt about scoring, the questionnaire was in addition evaluated by a second person, and consensus was reached.

A correct response to each of the questions was rewarded by a predefined number of points, ranging from one to six (table 1). The points obtained on each question were added, a total score for the questionnaire

calculated, and total and average scores were obtained for each group. We also wanted to test whether there were differences between the two groups' regarding grading and characterizing murmurs, report of false murmurs, and report of extra heart sounds. Data are reported as means with confidential intervals (CI) or range. Differences between the study groups were evaluated using Student's t-test. Calculations regarding group size and statistical power were done in retrospect. The reason for this was the difficulty of estimating the standard deviation (SD) prior to the trial. P values are two-sided, and values <0.05 are regarded significant.

RESULTS

Each student contributed two or three questionnaires. Forty-three of the students (89.58%) completed the trial. The number of questionnaires scored was 94 and equal in the two groups. Mean scores in groups I and II were 17.1 (SD = 5.8) and 17.4 (SD = 4.5), respectively. The difference is 0.3 points which was not significant (p>0.05). When grading the murmurs, the students using electronic stethoscopes had 26 correct and 25 incorrect responses, whereas the students using the wireless stethoscope had 24 correct and 30 incorrect responses. On characterizing murmurs the group using electronic stethoscopes had 37 correct and 72 incorrect responses, while the students using the wireless stethoscope had 42 correct and 69 incorrect responses. When tested for report of false murmurs, the group using electronic stethoscopes had 10 correct and 10 incorrect responses. The group using the wireless stethoscope had 9 correct and 11 incorrect responses. In addition, the reports of extra heart sound were 4 of 10 with electronic stethoscope whereas 6 of 11 with wireless stethoscope (Table 2).

DISCUSSION

The aim of our study was to determine how use of electronic and wireless stethoscope would influence cardiac auscultation skills of undergraduate medical students. We compared the performance on a cardiac auscultation test of a group of medical students using electronic stethoscopes to a group using wireless stethoscopes. Grading of murmurs was performed in a better manner by electronic stethoscope (50.98% for electronic stethoscope compared to 44.44% for wireless stethoscope). However, those who used electronic stethoscope characterized 37 of 109 murmurs while those who used wireless stethoscope characterized 42 murmurs from a total 111 murmurs. Therefore, in this case, wireless stethoscope (37.83%) was more efficient than electronic stethoscope (33.94%). It is noteworthy that those who made use of electronic stethoscope reported 10 false murmurs of 20 (50%) while those who adopted wireless stethoscope reported 9 false murmurs of 20 (45%). We are not aware of any similar studies comparing electronic and wireless stethoscopes.

It can be objected that our diagnoses were based on auscultation and not verified by echocardiography. However, we were primarily testing auscultator findings and not diagnostic interpretation. We justify the use of the cardiologists' auscultator findings as a gold standard for the students since one should not expect that the students would have greater auscultator proficiency than the cardiologists [3,5]. Some of the patients used in the auscultation test were, however, known to the cardiologists, and there is a possibility that their findings on auscultation could be biased by background information about these patients. When using points to grade the question it is of importance that the groups are evenly distributed on the patients. Not all the questions are applicable to all the patients, and the maximum number of points achievable varied between the patients. The two groups are evenly distributed on the test days and thus on our test patients. Each student was represented by two or three questionnaires (depending on the day of participation), and each questionnaire was treated as an independent variable in the statistical analysis. This is likely to underestimate the spread in the groups, but the averages, and thus the comparison of the two groups, are not affected.

The students received the electronic and wireless stethoscopes four months prior to the auscultation test. This should be sufficient time to get accustomed to the electronic stethoscope, although it is possible that a longer period is needed to take full advantage of the additional features. It is also possible that the students' skills in cardiac auscultation are insufficient to reveal an existing significant difference between the stethoscopes. There is, however, no available documentation that cardiologists perform better with electronic compared to wireless stethoscopes, but it could be of interest to investigate if this could be the case. The higher (of course, insignificant) number of false reports in wireless stethoscope compared to electronic stethoscope may be attributed to higher effect of noise on wireless stethoscope. Therefore, despite the attempts for eliminating extra noises, the wireless stethoscope still suffers from noise problem. However, as more people can hear heart sound simultaneously, students are able to hear heart sound by wireless stethoscope more than they do by use of electronic stethoscope leading to higher recognition capability. On the other hand, in addition to facilitating and accelerating education process for educators, wireless stethoscope is capable of reducing stress and irritation in patients caused by

repetitive visits by students. Furthermore, it is prioritized over electronic stethoscope in terms of reduction of infection transfer risk caused by approaching the patients.

Table 1: The questionnaire of this research.

Question	Alternatives	Points
Do you hear any murmur?	Yes/no	6
If so, is the murmur:	Systolic/ Diastolic /both	5
If you have heard a systolic murmur, how would you characterize it?	Holosystolic/Crescendo-decrescendo	2
Describe the quality of the systolic murmur:		3
Where is the murmur loudest?	Anatomical alternatives	3
Grade	1-6	4
Radiation?	Anatomical alternatives	4
If you have heard a diastolic murmur, how would you characterize it?	Rumbling, whistling etc.	3
Is the 2nd heart tone preserved?	preserved/ diminished/ not audible	4
Is the 2nd heart tone constantly split?	Yes/ no	1
Is a third heart tone present?	Yes/ no	1
What is the most likely cause of the murmur?	Options	2
Any comments?		Max 2

Table 2: Overview of the results in the two groups.

	Electronic stethoscope	Wireless stethoscope
Total score (mean ± SD)	17.1 ± 5.8	17.4 ± 4.5
Grading of murmurs, % correct	26 correct of 51 answers; 50.98%	24 correct of 54 answers; 44.44%
Characterization of murmurs, % correct.	37 correct of 109 answers; 33.94%	42 correct of 111 answers; 37.83%
Report of false murmurs, % correct	10 correct of 20 answers; 50%	9 correct of 20 answers; 45%
Report of extra heart sounds, % correct	4 correct of 10 answers 40%	6 correct of 11 answers 54.54%

CONCLUSION

In conclusion, Wireless stethoscope received higher score than electronic stethoscope. However, the number of false reports by wireless stethoscope was insignificantly more than electronic stethoscope because of the effect of noises; on the other hand, the number of true recognition by wireless stethoscope was higher. Taken together, although wireless stethoscopes suffer from the effect of noises which may cause more false reports, it is prioritized over electronic stethoscopes because it facilitates and accelerates education process and consequently, it may boost number of true recognitions.

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