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Knowledge, Attitudes, Practices (KAP) about Auscultation and Usability of an Electronic Stethoscope in 5th Year Medical Students at the Faculty of Medicine and Biomedical Sciences of Yaoundé (Cameroon)

Connaissances, attitudes, pratiques (CAP) sur l'auscultation et utilisabilité d'un stéthoscope électronique chez les étudiants de 5^{ème} année d'Etudes Médicales à la Faculté de Médecine et des Sciences Biomédicales de Yaoundé (Cameroun)

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ABSTRACT

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Objective: To evaluate knowledge, attitudes and practices (KAP) of 5th year medical students regarding the clinical auscultation and the usability of an electronic stethoscope for its use in Cameroon. **Methods:** A descriptive cross-sectional study was carried out with 5th year medical students. It was conducted in two parts: (i) the evaluation of KAP of 5th year medical students in terms of auscultation and (ii) a study of the usability of an electronic stethoscope. Data were collected through self-administered questionnaires. **Results:** 80 students completed the questionnaire on CAP for auscultation. The structure of the traditional stethoscope in general was known by only 42.5% of participants. 66.8% of participants were aware of the function of the bell and only 13.8% were aware of the usefulness of cardiac auscultation in Erb's focus. 96.3% of students felt that additional training in auscultation would be beneficial. The inability to filter and record sounds perceived with a traditional stethoscope was considered a limiting factor for the majority of them. In addition, 57.5% of participants had never heard about the electronic stethoscope. With respect to the usability of the electronic stethoscope, the majority of participants felt that it was easy to use and would make the practice of auscultation more relevant. **Conclusion:** This study highlights the need to strengthen and to modernize the training of Cameroonian health professionals in clinical auscultation by implementing new pedagogical approaches that can be based on digital technology.

RESUME

Objectif : Cette étude a pour objectif d'évaluer les connaissances, les attitudes et les pratiques (CAP) des étudiants de 5^{ème} année d'études médicales en matière d'auscultation clinique et l'utilisabilité d'un stéthoscope électronique dans la perspective de son utilisation au Cameroun. **Méthodes :** Une étude transversale descriptive a été menée auprès d'étudiants de 5^{ème} année d'études médicales. Elle a été conduite en deux volets : (i) l'évaluation des CAP d'étudiants de 5^{ème} année d'études médicales en matière d'auscultation et (ii) une étude d'utilisabilité d'un stéthoscope électronique. Les données ont été recueillies au moyen de questionnaires auto-administrés. **Résultats :** 80 étudiants ont rempli le questionnaire portant sur les CAP en matière d'auscultation. La structure du stéthoscope traditionnel en général était connue par 42,5 % des participants seulement. 66,8 % des participants connaissaient la fonction de la cloche et 13,8 % seulement connaissaient l'utilité de l'auscultation cardiaque au foyer d'Erb. 96,3 % des étudiants estiment qu'une formation supplémentaire en auscultation serait bénéfique. L'incapacité de filtrer et d'enregistrer les sons perçus avec un stéthoscope traditionnel était considérée comme un facteur limitant pour la majorité d'entre eux. De plus, 57,5 % des participants n'avaient jamais entendu parler du stéthoscope électronique. En ce qui concerne l'utilisabilité du stéthoscope électronique, la majorité des participants trouvait qu'il était facile à utiliser et rendrait la pratique de l'auscultation plus pertinente. **Conclusion :** Cette étude souligne la nécessité de renforcer et de moderniser la formation des professionnels de santé camerounais en matière d'auscultation clinique en mettant en place de nouvelles approches pédagogiques qui peuvent se baser sur le numérique.

INTRODUCTION

Auscultation is a technique that can be used to diagnose diseases whose pathophysiological mechanisms involve the emission of characteristic sounds by affected organs [1]. It is based on the use of an iconic acoustic instrument: the stethoscope [1]. Over time, this instrument has undergone a large number of modifications, with the aim of improving the sensitivity and specificity of auscultation. What was once a roll of paper was transformed into a cylinder of cedar wood, then to a light bi-auricular device, with a two-sided chest piece to perceive and filter low-pitched sounds [2].

With the development of information technologies, some manufacturers have developed electronic models of the stethoscope. These devices are capable of filtering, analysing and saving captured sounds [1].

In most curricula, apprenticeship in auscultation is very often initiated in the first year of clinical studies (fourth year of medical school) [3]. As an integral part of clinical examination, acquiring fundamental knowledge and competence in auscultation is a major challenge for medical education, especially in developing countries due to insufficiency of diagnostic tests [3,4].

Teaching and acquiring clinical skill of auscultation is a complex process [4,5]. For instance, in Cameroon, training in auscultation begins with a theoretical phase where sounds peculiar to certain pathological conditions are described. In a clinical setting (practical phase), teachers use a standard stethoscope to examine patients and identify characteristic sounds that they describe to medical students. Using a stethoscope, students also try to recognize these sounds in given patients. This training system has its limitations, because there are mismatches between theoretical knowledge acquired by students and practical skills. The former assertion is often true because these lessons are not done simultaneously (the theoretical phase being done a few weeks or even months prior to the practical phase). Moreover, it does not take into account technological advances made by the digital world, namely: filtering, recording and storing sounds, which allows simultaneous listening of sounds at bedside or otherwise by several learners [6]

The objective of this study is to evaluate knowledge, attitudes and practices of 5th year medical students in regards to auscultation in clinical practice, as well as usability of an electronic stethoscope in Cameroon.

METHODS

Study Design, Period and Setting

A descriptive cross-sectional study was carried out between May and October 2017 (6 months). Firstly, evaluation of the knowledge, attitudes and practices of medical students with respect to auscultation was done. This was done via a self-administered questionnaire at the Faculty of Medicine and Biomedical Sciences (FMBS), University of Yaoundé I (UYI) campus.

Secondly, a test evaluating the attitude of students regarding the utilization of an electronic stethoscope in Cameroon was conducted using a self-administered questionnaire at the Yaoundé Central Hospital, Cardiology department.

Study Participants and Inclusion Criteria

In regards to the first part of the study, all fifth year medical students (second year clinical studies at FMBS) who gave their consent to participate in the study were included.

Regarding the second part of the study, fifth year students with smartphones who were able to run the mobile app, Telegram were included [7]

Sampling

In the first part, consecutive non-probability sampling was performed whereas in the second part, five students were picked randomly to participate in the usability test.

Procedures

Knowledge, attitudes and practices of auscultation

Assessment of students' KAPs in auscultation was done using a self-administered questionnaire. This questionnaire focused on: (i) knowledge of the stethoscope and its structure; (ii) the place of auscultation in the day-to-day clinical practice of participants; (iii) difficulties encountered in the practice of auscultation and the possible need for training; (iv) and finally, the perception of limits of stethoscope models currently available on the Cameroonian market.

Usability of an electronic stethoscope in Cameroon

The usability test session began with an introduction to the participants, during which goals, process and materials to be used were presented. The list of equipment used included: a Littmann electronic stethoscope (model 3200), a laptop in which was installed StethAssistTM software (proprietary software that manages the acquisition and recording of audio files from auscultation), smartphones of participants in which Telegram social network application was installed (this application was chosen for its ability to transmit audio files in wav format).

Then, there was a training forum aimed at optimizing student's cardiac auscultation skills. Afterwards, we presented, to participants, features of the electronic stethoscope and procedures for recording, storing audio files from auscultation in a computer and exporting them for sharing via the Telegram social network. Twenty minutes were given to each participant to become familiar with the device.

The usability test of the electronic stethoscope for auscultation was performed in two 74-year-old and 60-year-old adult patients who consented to participate and were hospitalized in the cardiology department for aortic and mitral regurgitation respectively. The clinical scenario designed for this test was as follows: the student "Y" and the student "Z" fail to agree on the type of noise they perceive during cardiac auscultation of Mr / Mrs. "X" hospitalized few hours ago. They decide to record and share this auscultation with their colleagues for an additional opinion. The premise in this case scenario, was that each student could perform the following tasks: (i) perform auscultation of cardiac foci (aortic, pulmonary, Erb, tricuspid and mitral foci), (ii) record and store audio files obtained after this auscultation, (iii) and finally, share them via the social network Telegram. A

research assistant served as a facilitator during this session.

At the end of the test, each participant was asked to complete a self-administered questionnaire. Four aspects were evaluated during this usability test: the usefulness of the stethoscope, its ease of use, the ease of learning how to use the stethoscope, and finally the satisfaction of the user. Each aspect was rated using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Outcomes

- For the evaluation of the KAPs in auscultation: knowledge of functions of the classical stethoscope, knowledge of auscultation and attitudes and practices of students in auscultation
- For the usability of an electronic stethoscope: utility, usability, easy of learning and user satisfaction.

Statistical Analysis

Data was recorded and analyzed using IBM SPSS statistics for windows version 20.0.using Epidata v3.1 and IBM SPSS v20 softwares. Categorical and ordinal variables were expressed as proportions.

Ethics approval and consent to participate

The study was approved by the Centre Regional Ethics Committee for Human Health Research (Authorization CE N°0546/CRERSHC/2018). All participants received information about the study and they provided a written informed consent form prior their inclusion. Data collected were anonymized and used for scientific purposes only.

RESULTS

Knowledge, attitudes and practices of auscultation

Of the 120 medical students approached, 80 who met the inclusion criteria were able to complete the questionnaire.

In terms of auscultation knowledge, 98.8% (n = 79) of participants recognized the stethoscope as the fundamental tool of auscultation. The general structure (parts) of the traditional (classical) stethoscope was known only by 42.5% (n = 34) of participants. 66.8% (n = 55) knew the function of the bell. In addition, the usefulness of certain foci of auscultation such as the Erb's area was known only by 13.8% (n=11) of participants.

In terms of practice, 96.3% (n = 77) of participants used auscultation on a regular basis. These comprised mainly cardiac (n = 70), pulmonary (n = 70) and abdominal auscultation (n = 54). In adult cardiology, 97.5% (n = 78) of participants used to auscultate only 4 foci, while in pneumology 62.5% (n = 50) examined more than 4 areas bilaterally.

Difficulties related to auscultation were noted by 36.3% (n = 31) of participants. These included: low perception of low pitched sounds, difficulty in identifying pathological sounds, and inability to share with classmates for educational purposes, some cardiac and pulmonary sounds identified during the course of training. In addition, impossibility of filtering and storing sounds perceived using a conventional stethoscope was considered as a limiting factor for 67.5% (n = 54) and 68.8% (n = 55) participants respectively.

In terms of attitudes and perceptions, 85.5% (n = 70) of participants rated the stethoscope as an indispensable diagnostic tool in medicine. In addition, 96.3% (n = 77) of students thought that more in-depth training in auscultation would be necessary and beneficial for mastering auscultation. The need for more training was related to cardiology in 83.3% (n = 67) of cases and in pneumology in 56.3% (n = 45) of cases.

Furthermore, the majority (57.5%, n = 46) of participants had never heard of electronic stethoscopes. Only 11.8% (n = 4) of those who had heard of it had ever used it. Diagnostic auscultation help (51.3% of cases), amplification and filtering of perceived sounds (76.3% and 77.5% of cases respectively) as well as the possibility of saving and sharing sound files from auscultation with colleagues (50% of cases) were features that were deemed necessary and useful by participants.

Besides, the possibility for these stethoscopes to have autonomy in electrical energy (via rechargeable batteries) and to be accessible at lower cost, were characteristics desired by some participants.

Usability of an Electronic Stethoscope

The evaluation of usability of the electronic stethoscope was carried out according to 4 aspects: its utility, its ease of use, its ease of learning and the user's satisfaction.

Concerning the utility (table 1), the majority of students believe that the electronic stethoscope would make auscultation easier (n = 3) whereas the majority of them is neutral on its ability to be effective for the practice of medicine in general (n = 3) and its ability to meet their expectations and needs (n = 5).

Table I: Utility of an electronic stethoscope (n=5)

Items	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
More effective clinical practice		1	3	1	
Facilitates auscultation	1		1	3	
Time saving	1	2		2	
Meets my needs and expectations			5		

About ease of use (table 2), the majority of students doesn't have an opinion about the user-friendliness of the electronic stethoscope (n=3) and about the presence of inconsistencies when using it (n=3). However, the majority felt that this stethoscope does not require any special efforts to use it (n=3). Moreover, they claim to be able to easily correct errors made during its use (n = 4).

The ease to learn how to use electronic stethoscope was also assessed (table 3). The handling of the electronic stethoscope by students required a relatively short learning time (30 min maximum). The majority of them quickly learned how to use this stethoscope (n = 3) and easily remember how to use it (n = 3). Two out of five students quickly became skilled with this stethoscope.

Table II: Ease of Use (n=5)

Items	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
Easy to use	1	1	1	1	1
User friendly			3	2	
Less effort	1	1		3	
Can use without instructions	1	2		1	1
No inconsistency in use			3	1	1
Occasional or regular users will love using stethoscope	1	1	1		2
Can correct my errors easily and rapidly		1		1	3

Table III: Ease to learn how to use (n=5)

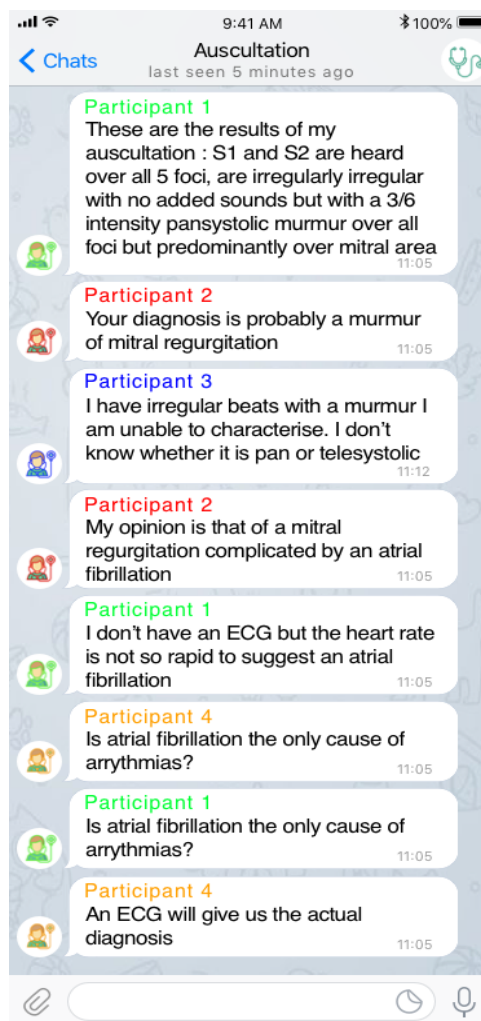
Items	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
Learned rapidly to use		1	1		3
Remember easily how to use		2			3
Became quickly skilled in using stethoscope		1	2	1	1

Finally (table 4), this electronic stethoscope was found pleasant to use by the majority of these students (n = 3), and was rated as a recommendable tool for a colleague by the majority of students (n = 3). In addition, one in five students was not satisfied with the use of the electronic stethoscope.

Table IV: User Satisfaction (n=5)

Items	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
I am satisfied	1		2	2	
Recommend for a colleague		2		3	
Fun to use	2		3		
I feel a need to have this stethoscope	2		1	1	1
Pleasant to use		2		2	1

The use of the social network allowed the participants to exchange their opinions on the audio files obtained (figure 1). This collaboration in real time made it easy to make a working diagnosis and an appropriate work up to improve patient care.

**Figure 1:** An excerpt of dialogue between participants

DISCUSSION

Cardiovascular disease is a major public health problem worldwide [8]. Three-quarters of people with cardiovascular disease live in resource-limited countries [9]. Diagnostic and therapeutic means being limited in these settings, prevention remains the most effective means [10]. In addition, when the first signs and symptoms occur, good clinical monitoring is of major importance in primary health care. In addition to being inexpensive [11], auscultation is an integral part of effective clinical diagnostics available to any well-trained health professional (especially physicians) [6,11,12].

As an essential component of the training of a health professional, especially for medical staff and in a context of limited resources, auscultation is a discipline that must be taught in depth both in terms of content and pedagogic approach. In this study, most medical students regularly use it, particularly in the context of heart and lung diseases. However, their knowledge and skills are still limited, as is the case in literature [4,5]. This could be explained by the difficulties they would have in assimilating various lessons and pedagogy means used to

favor the acquisition of this knowledge and skills [13,14].

In terms of content, the training of students in auscultation must ensure that most of the knowledge and skills required for a good mastery of the auscultation are taught, namely: to identify the normal and abnormal sounds of the heart, identify cardiac cycles and possible abnormalities, identify auscultation abnormalities that may occur at the pulmonary and even abdominal level, and finally be able to make links between these abnormalities and the underlying pathologies [15]

In terms of pedagogy, the current paradigm is that of mono-listening and mono-interpretation during the training in auscultation. With today's classic stethoscopes, the teacher only listens to the sounds with a stethoscope and then makes his own interpretation. Turn by turn, each student starts over the same process and makes their own interpretations. Discussion then follows between the teacher and students. There are two main limitations of this model: (i) uncertainty to which sound was heard by each one (especially if these auscultations are done by each student asynchronously) and (ii) the absence of a common gold standard reference frame for the interpretation (each interprets according to the sound he heard).

We propose a paradigm shift to the so-called paradigm of poly-listening and poly-interpretation. In this model, teachers and students would be equipped with a device that would allow simultaneous hearing by the teacher and by the students. In addition to face-to-face discussions, visual aids help students to objectively interpret sounds from auscultation, either via discussion platforms or annotated sound files. This paradigm could be reinforced by the implementation of a virtual library of sounds, namely cardiac sounds. Through this virtual library, students can listen pathognomic and annotated sounds at will and improve their self-training.

Achieving this vision requires integration of new technologies of auscultation such as the electronic stethoscope, which offers many advantages such as: the ability to filter, record and share sounds to others, via the discussion platforms [16]. This electronic stethoscope will have to be usable to facilitate the mastery of its use in auscultation by students [12]. In this study, the majority of students felt that the electronic stethoscope: was easy and pleasant to use and facilitated the practice of auscultation. However, as wished by the participants during this study, such an electronic stethoscope should be able to store or have back up energy to permit use even in remote areas (example: use of rechargeable batteries) and be accessible in terms of cost.

In addition, the development of a characteristic sound database coupled with expert annotations is a tool that can further enhance learners' competence in auscultation [3,17]. Setting up such a device could require a favorable infrastructural, organizational and regulatory environment like a school of auscultation [18].

CONCLUSION

Auscultation remains a relevant diagnostic method that is cheap and effective, especially for developing countries

where diagnostic means are relatively unavailable. This study stresses the need to modernize the training of health professionals in the field of auscultation, by putting in place more effective mechanisms to improve knowledge and skills of learners. This modernization of the curricula requires integration of possibilities offered by new technologies like the electronic stethoscope and the possibility to develop virtual libraries of sounds. However, for better integration, it is necessary that this electronic stethoscope is usable, accessible at a lower cost and satisfies certain technical constraints relating to the energy inadequacies observed in developing countries.

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List of Abbreviations

FMBS: Faculty of Medicine and Biomedical Sciences
IBM: International Business Machines Corporation
KAPs: Knowledge, Attitudes, Practices
UYI: University of Yaoundé I

Declarations

Availability of data and materials

The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Study conception and design: GB, FG, CNNG, JZM.
Data collection: FG, GB, CNNG.
Statistical analysis: FG, GB.
Drafting: GB, FG, CNNG.
Critical discussion and manuscript revision: GB, FG, CNNG, PS, JZM.
All authors read and approved the final version of manuscript.

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