Heart murmurs auscultation as professional learning problems

Profesyonel öğrenme problemi olarak kalp üfürümlerin oskültasyonu

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ABSTRACT

Objective: To compare the effectiveness of traditional and innovative methods of training for heart auscultation in medical students, physicians, and medical teachers, to find out the major reasons of the deficient auscultative skills, and to determine a place and significance of alternative methods of auscultation training.

Methods: By principle of other equal conditions, the comparison of traditional and algorithmic diagnostics by the same auscultative signs in textual tasks, magnetic sound records and heart auscultation of patients. The independent diagnostics has been reflected the results of usual medical education. The same data have been used by the same examinees for diagnostics by original innovative diagnostic algorithm of heart auscultation, and programmed training.

Results: Murmurs diagnostics on magnetic recording was erroneous frequently. For reliable diagnostics of acoustic phenomena is needed the constant feedback, and much more time, than is scheduled in standard curriculum.

Conclusion: Conventional training for heart auscultation is ineffective. Auscultation skills acquired by medical students do not grow up during their program of study. Even graduated cardiologists and instructors clinicians themselves make frequent errors in diagnostics of heart murmurs. The proposed diagnostic algorithm decreases the number of errors many times. The programmed teaching with constant feedback is the optimal method for flawless recognition of acoustic signs. *(Anadolu Kardiyol Derg 2009; 9: 167-75*

Key words: Heart murmurs; Heart disease; Diagnosis; Diagnostic errors; Differential Diagnostic Algorithm; Programmed training.

ÖZET

Amaç: Tıp eğitmenleri, doktorlar ve tıp talebelerinin kalp oskültasyon eğitiminde geleneksel ve gelişmiş yöntemlerin etkinliğinin karşılaştırılması bu araştırmanın amacını teşkil etmektedir. Ayrıca; oskültasyon becerisindeki noksanların ana nedenlerini bulmak; oskültasyon eğitiminde alternatif yöntemlerin önemini ve yerini de tayin etmek amaçlar arasındadır.

Yöntemler: Diğer eşit şartlarla birlikte; hastaların kalp oskültasyonu, manyetik ses kayıtları ve eğitimdeki aynı oskültatif belirtiler vasıtası ile geleneksel ve algoritmik tanısallar karşılaştırıldı. Bağımsız tanısallar günlük tıp eğitiminin sonuçlarını yansıtır. Aynı veriler, aynı sorgulayıcılar tarafından programlanan eğitim ve orijinal yenileşmenin diyagnostik kalp oskültasyon algoritmasıyla oluşturulan tanısallar için kullanıldı.

Bulgular: Manyetik kayıttaki üfürüm tanısalları sıklıkla yanlıştı. Akustik fenomenlerin gerçek tanısalları için standart müfredatla programlanandan çok, sabit geri bildirim, çok defa fazla zaman gerekmektedir.

Sonuç: Kalp oskültasyonu için geleneksel eğitim etkisizdir. Tıp öğrencileri tarafından elde edilen oskültasyon becerileri, onların çalışma programı esnasında gelişmez. Hatta mezun olan kardiyologlar ve klinisyen öğretmenler, kalp üfürümlerinin tanısında sık sık hatalar yapar. Önerilen tanısal algoritma, birçok defa hataların sayısını azaltır. Sabit geri bildirime programlanan öğreti, akustik işaretlerin kusursuz tanımı için en uygun metottur. *(Anadolu Kardiyol Derg 2009; 9: 167-75)*

Anahtar kelimeler: Kalp üfürümü, kalp hastalığı, teşhis, tanısal hata, ayırıcı tanısal algoritma, programlanan eğitim

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Abbreviations: DT - Diagnostic task; DDA - Differential Diagnostic Algorithm; PTAS - Programmed Training with the teaching machine "Siberia" and the Acoustic System for reproduction of heart auscultation sounds; s/s - symptoms/signs.

Introduction

This article discusses the results collected more than 30 years ago in the Department of Pedagogics and optimization of the higher medical education created by the author in the Novosibirsk State Medical Institute, former USSR, in 1970. For 15 years of the author's term as the head of this department, 3020 instructors from 85 to available 89 Soviet higher medical schools had finished its training courses in our department. The author has developed 15 innovative scientific-methodical trends and worked out 70 new systematic techniques of medical teaching optimization. Hundreds of students participated in different pedagogical experiments. These old data are being presented now because an effective way of teaching heart auscultation is still an actual problem, and these data essentially expand literary concepts of this problem.

Teachers of higher medical school, students and physicians are certain, that auscultation of heart sounds is easy and clear object. In fact, it is one of the most complicated problems of medical professional training. However, the serious contradiction exists between standard opinions, official curriculums on the one hand, and the reality. This contradiction is caused by discrepancy between complexity of a subject of training, on the one hand, a method and school hours of training, scheduled in accepted curriculum, on the other hand.

Official curriculum focused on the well-known classical method of mass education, which is traditional in school and professional teaching (later "traditional training"). Comparison of the results by traditional and proposed innovative methods of cardiac auscultation training is a fundamental methodological tool of this research.

Unlike the standard one, my technique of programmed training puts together different methods and tools in a single complex. This complex consists of the following parts:

1) The short text-based model of the patient presented as a list of the patient's typical s/s and other medical documentations needed;
2) The training machine "Siberia" (Fig. 1).
3) The standard normal and pathologic heart sounds playing back from the disks included in the Great Soviet Medical Encyclopedia (Fig. 2-4);

All the training tools provide continuous corrective feedback (Fig. 1-4).

The Novosibirsk State Medical Institute was the reference teaching school at that time. Our department was the first and the best in the former USSR. For that reason, it was a preferred place to improve and advance pedagogical skills for many professors and medical teachers almost from all Soviet medical schools (mentioned 85 ones). Therefore, the results presented in this paper do not reflect a negative situation in a given medical school, but show of the general widespread phenomenon.

In the five tables below, totally 4749 written diagnoses were analyzed: among them 2489 were done with diagnostic textual tasks, 1808 the PTAS conclusions, 325 diagnoses at patients with heart diseases, and 127 phonocardiograms in real patients with heart diseases.

Methods

1. Technical methods of combined training for medical sounds diagnostics (Fig.1-4).

Figure 1. The original technical device for programmed training "Siberia" («teaching machine» - TM). The tips inserted into beforehand prepared apertures of a punched card, close contacts of right answers. Any other answer (pressing of the toggle switch, which is not corresponding to number of a right answer of the training program), not corresponding programmed correct, will give a signal of a mistake. These are the red bulb on the case of TM, and the bulb in the bottom line of a remote panel.
The remote panel on the TM "Siberia" is established on a high rigid crossbar. The panel turns almost on 360 degrees. The top line of bulbs (thyratrones) shows, how many stages of the training program have been solved already. The bottom line of bulbs fixes each mistake made at corresponding stages of the task decision. The big green bulb on a panel on the right shows the ending of a task decision. High position of a panel above heads of students allows the teacher from his workplace at once to see a situation with the decision of tasks by every student
TM - teaching machine

Figure 2. Dubbing standard heart sounds from the disks of the Great Soviet Medical Encyclopedia to a tape recorder. In the equipment room 24 tape recorders work. The standards of the normal and pathological heart sounds have been reproduced on 6 of them (at the left). On other 18 tape recorders individual sound problem situations have been reproduced. On each tape recorder its serial number and removable number of a sound task are presented.
Between of the equipment room to each of 36 students' workplaces in three classrooms multichannel antijam communications by the shielded wires providing irreproachable clean sound characteristics. Between of the technicians in the equipment room and each workplace in a classroom the direct sound communication takes place. If a short break for rewind of a film is necessary, then a student has received a notice in his earphones (Fig. 3)

Figure 3. The PTAS - combination of Programmed Training by means of the TM "Siberia" + Auscultative System. Both systems have developed by the author, the manager of the department of pedagogics and optimization of the higher medical education in Novosibirsk medical institute. Each student has receives an individual acoustic task through headphones and sign by sign solves it by means of the training program and the TM. The success of the training has provided by the sound system and the feedback by the TM. By these both systems was fulfilled a training of all sound medical phenomena - pulmonary, heart auscultation, a speech of patients with mental disorders
TM - teaching machine

2. Methods of comparative evaluation

Our special researches show unreliability of the examinations grades. Right away after graduation examinations in medical school, 27% to 52 % of graduates who got high average grades in internal illnesses for III-VI years made gross blunders in diagnostics of simple textual auscultative and other DT. Therefore, original method of comparative evaluation was developed.

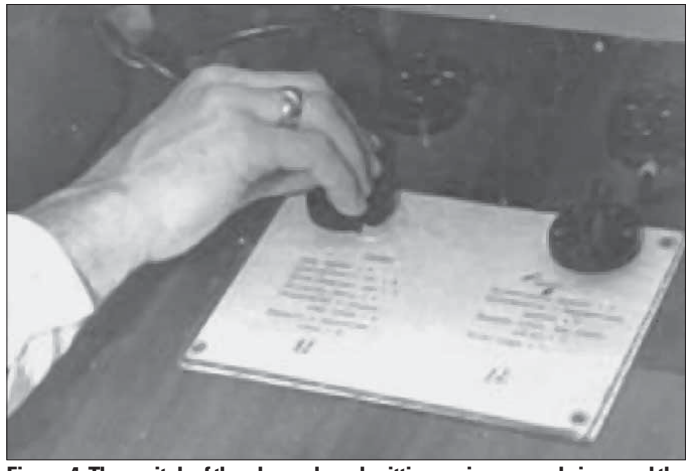

Figure 4. The switch of the channels, submitting various sound signs and the sound standards. Under the switch is the list of channels and sounds phenomena. If the TM fixed an error, a student has compare of his personal sound task with each sound standard at any moment, and after correction has continued of his DT. So actually sounds signs programmed training to its correct recognition have been combined
TM - teaching machine

The methodology of a comparative evaluation of results traditional and innovative methods of training of auscultation had general principles. Popular division of examinees on basic and control groups was unsuitable for our purposes. The matter is that professional mental abilities, which are non-comparable at different people, have compared. Therefore, the author has developed a technique of comparison of effectiveness of professional work of the same people at different methods of training.

It was strict observance of the principle of other equal conditions: the same examinees, the same tasks at the same time. The single difference was different methods of training: 1) Traditional training; 2) Training by original innovative methods by means of diagnostic algorithms and PTAS.

The technique of comparative experiments has been carried out in two stages. At the first stage, there was independent diagnostics of textual tasks and the magnetic sound records of heart tones and murmus with written down of diagnoses. At this stage of independent diagnostics results of traditional training became known. After these records with diagnoses have been selected from examinees, they at once started the second stage of experiment and solved the same tasks by new methods. Records with new diagnoses at the second stage have been selected, and then results of the first independent and the second innovative stages of experiment were compared.

A comparison of the efficiency of comparable learning does not require complex mathematical formulas. My comparative method is simple and available to all:

$$\text{the number of errors at learning by the } \frac{\text{old method}}{\text{new method}} \text{ expressed by multiplicity reduction.}$$

For example, the 10/10 = results are stable, reduction of the errors number and improving of the learning outcome is absent.

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Hence, the new teaching method has no advantages over the old one. Other examples have other results. Reduction errors, 10/5 = 2 times, 10/1 = 10 times, hence, number of errors at learning by new method of 2 and 10 times less than at classical traditional training method. Just the number of errors in decision of professional tasks can serve as the basic criterion for the quality of education. The fewer mistakes, the better a quality of professional training.

The objects of comparison were medical students of I-VI years, physicians, teachers of departments of internal illnesses from numerous medical institutes of the former USSR.

3. Method of the unique experiment on itself of heart auscultation training

The special methodology has been developed for experiment with the purpose of revealing necessary time for mastering of heart auscultation.

There is a serious theoretical basis for programmed training of auscultation. Traditional training uses the first didactic system «one teacher – many pupils». It forms only I-II levels of training «knowledge-acquaintance» and «knowledge-copies». It is impossible to provide of III level of professional training «a task – the optimal professional decision» (effective professional practical activity) by such methods. True methodically correct programmed training at once forms of III level of training – effective professional work (11).

Very often mistakes appear as the result from standard traditional training. True optimal methods effectively eliminate lacks of traditional training.

Conditions of the experiment on itself

At my request 16 students-volunteers of the first and second years, members of student's scientific study group at my department have agreed to study of heart auscultation by means the PTAS. They never studied a theme of a heart auscultation.

First-two-year students had no any value. On first two years medical students do not communicate yet with patients and do not study clinical disciplines. The purpose of the experiment was to find out, what real time is necessary for practical mastering of sound signs of healthy and sick heart.

Especially emphasize, at training in the perfect conditions, which never it happens on usual practical training in clinic.

1) Students began learning auscultation in their headphones listening of the normal heart sounds verbal characteristics. The explanations were accompanied by magnetic record of normal tones. Each student may repeat these records many times. Such conditions never occur in the training of auscultation in clinical conditions (Fig. 2-4).

2) Auscultation of pathological sound signs was compares constantly to standard records of normal tones and with each pathological sign and voice explanation in headphones. This comparison has made by means of the switch of channels (Fig. 4, Fig. 2 left tape-recorders with permanent standard sound signs).

3) At this stage of self-training the "Siberia" (Fig. 1) it was not switching on. Work went only with acoustical training without a feedback.

4) Each exercise had designed at two hour continuous self-training. Students could stop work earlier or after this term. The work has been stopped at completely confidence of the student, that each sound sign is recognized correctly.

5) Each student many times repeated listening record of heart sounds on the same exercise until there was a confidence of correct practical recognition of each sound sign. Depending on individual abilities of students various duration and number of recurrences of auscultation of different sound standards was required.

By the figures outside of brackets have indicated the average, and into brackets - the minimal and maximal numbers of given sign listening by different students. Normal tones of heart - 10 (3-22), amplification of tones - 5 (3-8), splitting of tones - 5 (3-10), systolic murmur - 9 (3-21), diastolic murmur - 7 (2-19), arrhythmias - 6 (2-12). For mastering by the specified sound phenomena students spent from 3 till 126 minutes on each sign, totally - from 74 till 449 minutes (from 1,6 up to 9,98 school periods for 45 minutes).

This first period of experiment has engaged five two-hour exercises with continuous listening of sound phenomena. This time of confident mastering of each sound was the SELF-ESTIMATION of students. The falsity of such self-estimation has become obvious right after the repeated decision of sound phenomena by means of the PTAS.

6) At the subsequent work with the PTAS, numerous mistakes have been found out. Students were extremely surprised with an abundance of the mistakes AFTER prolonged self-training, AFTER a confident self-evaluation in correct definition of each sign.

Therefore, all volunteers have carried out 3 additional four-hour self-training with the PTAS.

After switching on the "Siberia" the students again put on one's headphones and started diagnostics of sound signs repeatedly. However, the "Siberia" fixed each mistake already at each student at each sound task (Fig. 1 the bottom line of bulbs).

7) At this stage of programmed management with permanent feedback the exercises were four-hour. Students repeatedly many times listened of sound phenomena and pressed the toggle switch of the answer only at full confidence, that they, at last, have correctly determined the given sign. The psychological motivation was the highest. Each student did not want "to be dishonored" before friends who at once will see his/her mistakes on remote panels of "Siberia".

It turned out, that the most difficult was clear-cut distinction between systolic and diastolic murmurs - 53%, 41%, 35% errors within three consecutive exercises with PTAS, and many times of preliminary listening without of a feedback.

8) After end of independent work on each exercise all sound signs were reproduced through loudspeaker, and each mistake fixed by the PTAS on the "Siberia" was discussed in detail. Nevertheless, on the following exercise mistakes were repeated. Their number decreased rather gradually.

The experiment has been completed, after the third exercise when the number of mistakes remained high - from 35 % up to 12 %, and under the major characteristics - to recognition types of murmurs and a diagnosis of mistakes made 35-18%.

Statistical analysis

Statistical analysis was performed with Fisher's exact test using QuickCalcs Online calculator for scientists.

Results

The most demonstrative impression about a learning efficiency makes the analysis of diagnostic errors quantity at both stages of examinees' work (Table 1-4).

There was a higher percentage of correct diagnosis of murmurs in DDA group as compared with independent diagnostics group ($p<0.0001$ for all) (Table 1).

There was also a higher percentage of correct diagnosis of murmurs in sound records group as compared with independent diagnostics group ($p<0.0001$-0.0026 for half of groups) (Table 2).

Auscultative pulmonary diagnostics is unsatisfactory, as well as heart. At diagnostics of a magnetic sounds recording pulmonary pathology with the PTAS the graduates have made 42% of mistakes (Table 5).

Discussion

Tables 1-3 display very high level of diagnostic errors at the decision of DT (19-75%), at recognition of a magnetic sound recording (14-70%), and at auscultation of real patients (28-75%). With increase of an educational level and professional practice the number of mistakes even accrues. Cardiologists are mistaken even more often, than students of V-VI years are. At heart auscultation of real patients, graduates are mistaken in 2-2.5 times more often than students of IV year, and mistakes of cardiologists are often, as well as at students IV year. Frequency of diagnostic mistakes at teachers and professors amazes at diagnostics even on text tasks (75% and 40% accordingly). The diagnostics of textual tasks, i.e. the easiest task, teachers and professors have solved worse, than students.

Unexpectedly often mistakes (59%) were found out in the professors managing departments of internal illnesses at diagnostic interpretation of the phonocardiogram. Right after records of the independent diagnoses, they interpreted the same phonocardiogram with corresponding algorithm. The number of mistakes with algorithm has decreased up to 3%. In 20 times! In 1 minute! At the professors managing departments of internal illnesses!

The decision of textual DT represents only intellectual task. The major s/s, which are necessary and sufficient for differential diagnostics and the reliable diagnosis have directly printed in cards. The examinee should transform available s/s into the diagnosis. Nevertheless, often mistakes in this category of experiment convince of an inefficiency of cogitative operations not only at students, but also at physicians, and teachers, including professors.

It also shows the basic contradiction between traditional clinical thinking, and physician's practical activity. Descriptive nosological thinking, which is formed in higher medical school and almost all medical literature, firstly names a diagnosis (the name of illness), and then describes a disease s/s characteristic for this disease. The main problem is that many of the same or similar s/s meet at other illnesses. Differential diagnostics is too descriptive and usually does not allocate a minimum of decisive sign.

Optimal diagnostic practice has bases on an opposite syndromic principle. Not from the diagnosis to s/s, but from the revealed s/s through economical differential diagnostics to the most probable diagnosis.

Students, physicians and even teachers-clinicians not always can make revolutionary opposite transformations in the brain independently at constant deficiency of time.

Table 1. Diagnostics of heart valve diseases per textual diagnostic tasks (%)

Investigated groups	Independent diagnostics		Diagnostics with DDA		p*	Reduction of errors with DDA in times (~)
	+ and ±	errors	+ or ±	errors		
III	51	49	83	17	<0.0001	3
IV	48	52	82	18	<0.0001	3
V	65	35	91	9	<0.0001	4
VI Pediatric faculty	81	19	96	4	0.0014	5
VI Medical faculty	73	27	98	2	<0.0001	13
Cardiologists	63	37	93	7	<0.0001	5.5
Therapeutist teachers of medical institutes	25	75	100	0	<0.0001	75-0
Therapeutist heads of departments of therapy	60	40	94	6	<0.0001	7
Therapeutist heads of depart-ments of therapy, diagnostics by phonocardiography	41	59	97	3	<0.0001	20

*- by Fisher's exact test

+ correct complete diagnosis; ± correct, but incomplete diagnosis; - erroneous diagnosis. + and ± have been united as positive decision; III-VI – years of training in medical school

Our algorithms have provided reduction of mistakes - at 3-20 times, and even reduction from 75% of mistakes up to 0% even at their single use (Table 1).

Overall, 14-70% mistakes have been made at recognition of a magnetic sound records of heart diseases classical s/s. Graduates and cardiologists distinguish sound signs of a heart pathology even worse (70% and 60% errors), than the students less trained of auscultation (Table 2).

It is essentially important, that programmed training by means of the PTAS with an ideal constant feedback within 4 hours has given auscultative diagnostics quite insignificant reduction of mistakes - in 1.4-2.2 times at students and in 3 times at cardiologists.

At all examinees had the algorithm of heart auscultation. This is compelling evidence that optimization of thinking by means of algorithm is insufficient for substantial improvement of acoustical signs diagnostics. The answer to a question on the reasons of inefficient training for acoustical diagnostics gives the analysis of the Table 5.

Overall, 28-75% mistakes have been made as well at heart auscultation of patients (Table 3). It is surprising, that cardiologists are mistaken just as frequently (28%) as well as students IV year, which only begin studying cardiology.

For patient's auscultation, the examinees were offered only those patients with acoustical phenomena of heart and the diagnosis verified by preliminary phonocardiography (an echocardiography has not been applied yet in the former USSR at that time). Single four-hour work with the PTAS has given almost the same minor improvement of results auscultation (1.7-2.2 times), as well as at diagnostics on a magnetic sound record, and students IV year were mistaken even little bit more often, than at initial independent auscultation (28% and 32% accordingly).

The roughest contradiction between official curriculum and result of its practical realization is displayed in the Table 5, where the structure and dynamics of mistakes quantity at the decision of acoustical tasks on tape recorder and the PTAS have been presented.

The experiment has been completed after the third exercise, when the number of mistakes remained from 35% up to 12%. The errors at murmurs recognition were 35%, and the errors of diagnosis 18%. The worse result (35% errors) was just at differentiation between systolic and diastolic murmurs, that is decisive sign at heart diseases diagnostics. Distinguishing of normal tones and pathologic murmurs is easiest sound task.

For confident mastering of correct acoustical recognition and logic exact interpretation of the major heart pathology the 3-4 more four-hour exercises in mentioned conditions would be necessary.

The structure of auscultative mistakes by means of PTAS has been revealed that the characteristic of heart tones on the apex, A2 and P2 has differentiated more difficultly. Diagnostic errors at heart diseases have made mainly from third up to almost half, and were often at graduates, than at V year students (Table 4).

Such negative results are not feature of inefficient training of diagnostics heart diseases in Russia. Similar and even worse results at heart auscultation have been established in different countries (1, 4, 6, 7-9). Unsatisfactory qualification of students and physicians has been established in three English-speaking countries USA, UK, Australia (4). The authors characterize low qualification of students, trainees and doctors in heart auscultation, with strong expressions “a disturbingly low identification” (20% correct diagnoses) (9), “recognize heart sounds is alarmingly low (21% correct diagnoses) (1).”Only 18-30% of correct diagnoses have established by residents. Residents who had completed a cardiology rotation have increased of heart diseases diagnostics accuracy up to 41-46 % (4). The trainees' accuracy ranged from 0 to 56.2% for cardiology fellows and from 2% to 36.8% for medical residents (8).

What axioms are getting obsolete?

The results presented in the Tables 1-5 allow reconsider the following habitual axioms.

1) Positive official estimations in examinations do not reflect real quality qualification of students and physicians, in particular, in skill of heart auscultation. An effective thinking has not generated; therefore, diagnostic errors occur often, even at the decision of textual DT.
2) A quality of a heart and pulmonary auscultation of medical students, physicians, and even medical teachers

Table 2. Diagnostics of heart valve diseases per sound records (%)

Investigated groups	Independent diagnostics		With PTAS		p	Reduction of errors with DDA in times (~)
	+ and ±	errors	+ and ±	errors		
III	32	68	54	46	0.0026	1.5
IV	76	24	84	16	NS**	5
V	75	25	81	19	NS	1.3
VI Pediatric faculty	86	14	93	7	0.1652	2
VI Medical faculty	30	70	68	32	0.0001	2.2
Cardiologists	40	60	80	20	0.0001	3

** - non significant

+ correct complete diagnosis; ± correct, but incomplete diagnosis; - erroneous diagnosis. + and ± have been united as positive decision; III-VI – years of training in medical school

professional training is unsatisfactory, and has been accompanied by often mistakes.

3) This quality does not rise in process of increase of duration of traditional medical education in reality.
4) Daily practical activity with a constant heart auscultation is not a tool and a guarantee of effective self-training of auscultative diagnostics.
5) There are three major reasons of unsatisfactory auscultative training of students, physicians and even medical teachers. The first cause is not optimal thinking; the second one is ineffective methodology of sound semiology training, the third is insufficient time.
6) A DDA of heart murmurs is intend for the most effective thinking optimization only. A DDA not optimize of perception and recognition of real heart tones and murmurs.
7) A programmed self-training of heart and pulmonary sounding in norm and pathologies has a main role and the maximal value in formation of professional skill of auscultation.
8) Determinative in medical sound self-training is the constant continuous sound and verbal feedback, which purpose is to explain each normal and pathological sound phenomenon and to compare its among themselves.
9) It is necessary to create new optimal forms and methods of self-training of heart auscultation.

Presented data remains actual and today, and induce to reconsider critically existing ideas and methods of traditional training of heart auscultation.

Practical mastering by the major professional skills demands, firstly, other methodology of training, secondly, many times greater time, than it is prescribed by official curriculums of the higher medical education.

The above-mentioned conditions of training were not anywhere and never. Nevertheless, even many times repeated listening of each s/s with its detailed explanation, even constant comparison with sound samples, repeated lengthening of time of training has not provided full correct professional skill.

What means many times greater time practically? In the given experiment, time of continuous listening with constant comparison with sound standards has made 22 hours (10 school hours without a feedback + 12 hours with PTAS). However, after such intensive training in perfect conditions with the subsequent detailed discussion of each error, 35% of students were mistaken in distinction systolic and diastolic murmurs.

However, even 500 (five hundred!) repetitions improve auscultative recognition of murmurs from 14-21% to 85-86%. Hence, even after 500 repetitions there were 14-15% errors in recognition of the heart murmurs (12).

Thus, for confident mastering of heart auscultation it is required to EACH STUDENT not less than 60-80 hours of direct listening auscultative signs.

In generally accepted conditions of training at bedside, such radical increase of lessons for heart auscultation is impossible. It demands search of new organizational and methodical forms of auscultation training. Some ideas have been stated in the conclusion of the article.

Table 3. Diagnostics of heart valve diseases per heart auscultation (%)

Investigated groups	Diagnostics at real patients		After PTAS		p	Reduction of errors with DDA in times (~)
	+ and ±	errors	+ and ±	errors		
IV	72	28	68	32	NS	0.9
V	64	36	79	21	0.0278	1.7
VI Pediatric faculty	71	29	77	23	NS	1.3
VI Medical faculty	25	75	71	29	0.0001	2.6
Cardiologists	72	28	89	11	0.0039	2.5

+ correct complete diagnosis; ± correct, but incomplete diagnosis; - erroneous diagnosis. + and ± have been united as positive decision; III-VI – years of training in medical school

Table 4. Structure of errors at auscultative diagnostics with the PTAS (%) conventional notations

Character and location of murmurs	Students V year		Students VI year		p
Heart tones on apex	45	55	62	38	0.0231
Heart tones on A2, P2	58	42	46	54	NS
Character of murmurs	67	33	69	31	NS
PMI of systolic murmurs	71	29	69	31	NS
PMI of diastolic murmurs	85	15	77	23	NS
Diagnostic conclusion 68	32	54	46	NS	

+ correct complete diagnosis; ± correct, but incomplete diagnosis; - erroneous diagnosis, III-VI – years of training in medical school
A2 - aortic region – right upper sternal border, P2 – pulmonic region – left upper sternal border, PMI – point of maximal intensity

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Table 5. The unique experiment of heart auscultation training (%)

Heart tones		
	+	-
1	24	76
2	71	29
3	76	24
Arrhythmias		
1	53	47
2	59	41
3	88	12
Presence of heart murmurs		
1	88	12
2	100	0
3	100	0
Murmurs' character		
1	47	53
2	59	41
3	65	35
Diagnostic conclusion		
1	41	59
2	65	35
3	82	18
Diagnostic conclusion in 5 months		
+	±	-
64	18	18

+ correct complete diagnosis; ± correct, but incomplete diagnosis; - erroneous diagnosis

Main from its - to take out of complex self-training of auscultation from frameworks of scheduled clinical lessons and to begin a self-training of auscultation from the first day of training in medical institute.

In real conventional conditions of clinical group training at bedside students can graduate of higher medical school, never having heard a sound picture of some pathological changes of heart and lungs. Whether it is necessary after that to be surprised to often diagnostic mistakes of students, physicians, and even medical instructors?!

Last years good computer-based (2, 3, 5, 10) and Internet systems (1, 7) reproducing sound signs of a different pathology of heart and lungs have appeared. From the point of view of availability and compactness, modern technical means have obvious advantages before our unique PTAS more than back thirty years. However, the data resulted here allow to make a basic critical remark. The Table 5 shows, that in training of auscultation the decisive factor is a self-training. The major factor and the tool of self-training is the constant continuous feedback.

Any samples of sound-reproducing systems having only sound semiotics of illnesses, are insufficient for guaranteed self-training, and cannot provide maximal efficiency of self-training.

Sound-reproducing training systems of heart and lungs auscultation should have a sound and text verbal feedback for each sound sign necessarily. Only in this case the student can master by reliable diagnostics, stable results, and provide a real skill of auscultation.

Conclusion

Traditional nosological training of heart auscultation does not form effective clinical thinking. Therefore, even simple textual DT with the list of typical s/s of heart diseases has been solved with often errors.

The verbal description of sound s/s does not form sounds recognition and correct perception of s/s heart auscultation.

The most effective method of auscultation training is individual self-training with use of sound standards.

At self-training of recognition and distinction of heart and pulmonary sound phenomena, the self-evaluation of training results is deceptive and overestimated. Therefore, the feedback on each sound sign has crucial importance. Without a constant feedback, an effective faultless training of heart auscultation is impossible.

Practical skill of recognizing and differentiation signs auscultation of heart and lung demands much more time, than is specified in official curriculums and plans.

Modern computerized training sound-reproducing systems well simulate normal and pathological sounds of heart activity. However, its do not provide a constant feedback. Such systems should be transformed with obligatory inclusion of a feedback and the opportunity to listen any sound sign at any moment of sound self-training.

Training of heart and pulmonary auscultation should begin at higher medical school not from the third year, but from first day of training. This non-standard pre-clinical training is expedient for carrying out by means of diagnostic algorithm with text tasks and sounds recording on disks.

Such training should be voluntary and in every possible way be encouraged. Game forms of self-training, competition, local Olympiads for the best mastering heart and pulmonary auscultation are desirable. Each first-year student should receive as a present a disk with standard recording of all normal and pathological sounds of heart and lung, and verbal comments of the completely sound picture.

The general results of professional training will become many times better, if optimal methods of training will be applied in all clinical spheres as constant, and not just in an experimental comparative evaluation.

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