Developing Skills in Cardiovascular Primary Prevention in Undergraduate Education for a Vertical Integration of Physiology

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SUMMARY

Physiology is a discipline that plays a key role in the integration of basic and clinical science. Knowing and understanding the adaptive mechanisms of the body to the different physiological and pathophysiological scenarios are essential for clinical thinking. The growing gap between basic and clinical disciplines, particularly in discipline-oriented curriculum, has generated the need for educational tools in order to contextualize, integrate, motivate and encourage students in the active learning of the most relevant concepts of professional practice.
We designed a course for developing skills in cardiovascular primary prevention that would allow undergraduates to calculate the cardiovascular risk in healthy patients, induce changes in their habits, and, at the same time, contextualize the physiological knowledge. A total of 100 second-year medical students were recruited from the chair of Physiology of the University of Buenos Aires Medicine School, together with 11 ex-students who took the first two courses with real patients in a school based on the OSCE (Objective Structured Clinical Evaluation) guidelines. The course consisted of six encounters lasting 150 minutes reflecting routine medical activity: physician office practice (50 min) and seminar-debate (100 min). The students presented oral conclusions of the encounter, integrating the patients seen in the office with the bibliography. The evaluation of physician office practice was made with a checklist of 33 items and a document of 16 questions. Training followed the checklist for each case (hypertension, hypercholesterolemia, smoking habits, metabolic syndrome). The course was completed by 96 students. The difference between the pre-test and post-test scores obtained in the checklists (0 to 10) was calculated using the paired t test; showing a significant difference in the post-test score [3.80±2.08 vs. 9.60±0.58, pre-test - post-test difference –5.69 (95% CI –6.11, –5.277; p <0.001]. The present course and the school allowed incorporating the first medical skills in students without or with a little clinical experience in a significant area of public health.

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Key words > Educational Evaluation - Clinical Competence - Medical Education

BACKGROUND

Physiology is a discipline that plays a key role in the integration of basic and clinical science. Knowing and understanding the adaptive mechanisms of the body to the different physiological and pathophysiological scenarios is essential for clinical thinking. This vertical integration of Physiology has consolidated competency-based curriculum as an adequate approach for the organization of the different aspects of educational planning (procedures, methods and evaluation) following a proper educational guideline. (1)

Competencies may be defined by the specification of knowledge, skills and attitudes applied by a subject to solve problems in a particular context (2) and can be divided into transversal (also called generic or central) competencies and specific competencies. The former include interpersonal communication, teamwork, leadership, commitment to work, critical analysis, constant self-criticism and intellectual honesty, among others. Specific competencies are related with the activity developed (the process of reasoning with reversibility, knowing patients from a holistic and Gestalt approach, critical review of articles,

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searching for information, hypothesis formulation and justification, planning, development of diagnoses and treatments and measuring of variables, among others). (2-4)

Primary prevention is one of the most powerful tools of medicine, particularly in cardiology (5). Most Schools of Medicine are trying to improve the education in the area of public health and prevention. (6)

The goal of the present study is to communicate the results of the evaluation of eight courses on cardiovascular primary prevention as a strategy of vertical integration of Physiology for undergraduate students of the University of Buenos Aires Medicine School.

The students were trained in competencies in order to elaborate the Framingham score (7) from real and simulated patients seen at the out-patient clinics. The students presented their patients in clinical seminars reflecting routine medical activity similar to their future practice as medical residents.

MATERIAL AND METHODS

During the period 2006-2009, students taking the course of Physiology or having completed it were invited to take part in the courses given at the Instituto de Investigaciones Cardiológicas "Prof. Dr. Alberto C. Taquini" (ININCA) in the Autonomous City of Buenos Aires. A total of 100 second year medical students were recruited from the chair of Physiology of the University of Buenos Aires Medicine School. Eight on-campus courses were given in six encounters per week; each encounter lasted 2:30 hours, completing a total duration of 15 hours per course. The first evaluation or pretest was taken during the first encounter. The final evaluation or post-test was taking at the end of the course. Each encounter included two activities:

Physician office practice where the students received training in four areas of competence: Medical Interview, Physical Examination, Cardiovascular Risk and Counseling-Evaluation (50 min).

Seminar-debate, at a Conference Room (100 min). The clinical seminar-discussion focused on the pathophysiological approach of major factors of endothelial dysfunction. Students were observed while they interrogated healthy patients, estimated anthropometric measurements (8) and blood pressure to calculate the Framingham score and thus determine the cardiovascular risk. (7, 9) Pre-test and post-test evaluations were used to measure the performance of the course. In addition, the remaining encounters focused on the performance on evaluating the presence of hypertension, (10, 11) smoking habits (12), dyslipemia (13) and metabolic syndrome. (14) Physicians' offices were set up at the Instituto de Investigaciones. The evaluation of physician office practice was made with a checklist of 33 items (Table 1). The physiological basis of the cognitive competencies were evaluated with a 16-question written examination (Table 2). To pass the test, students needed to answer 60% of the questions correctly.

As the courses advanced and the first groups of students graduated, more patients were needed for developing competencies. For this reason, we used standardized or simulated patients trained to act as real patients following the guidelines of the OSCE (Objective and Structured Clinical Evaluation) which uses standardized patients to evaluate clinical skills in medical students without exposing real patients to embarrassment or unnecessary risks. In this way, the same course created a feedback of instructors and trainees in primary prevention. The student could play the double role of patient and assessor. Standardized patients have been widely used in analyses based on performance (step 3 of Miller's pyramid) or clinical practice (step 4 of Miller's pyramid). (15)

The evaluation of the results of each course was performed comparing pre-test and post-test scores, an examination based on standardized questions and a satisfaction survey. A rating scale from 0 to 10 was used for checklist assessment according to the percentage of items with correct answers, similar to the scale used at the Medicine School. The difference between the pre-test and post-test scores was calculated using the paired t test; a p value < 0.05 was considered statistically significant. All the statistical calculations were performed using the software package SAS 9.

Kappa statistics was used to compare the differences between the evaluators in the checklists.

The theory-based questionnaire (Table 2) required 60% of correct answers and was passed by all the students that completed the course.

Finally, the process was evaluated using a satisfaction survey (Table 3).

RESULTS

The course was completed by 96 of the 100 students initially recruited (median age: 21 years); these students attended 80% of the classes, a requirement to qualify for the final evaluation (post-test).

The interobserver variability was analyzed using kappa statistics: κ = 95% CI, 0.94 (0.87-1).

The results of the pre-tests and post-tests, expressed as mean and standard deviation (data with normal distribution), were 3.88 ± 2.1 and 9.58 ± 0.55, respectively (Figure 1). The difference between the pre-test and post-test scores was –5.69 (95% CI, –6.11, –5.277; $p < 0.0001$).

The same post-test was taken by 10 sixth-year medical students who did not attend the course, with the goal of evaluating the competencies acquired in the area of primary prevention. The mean score obtained was 3.80 ± 1.60.

The results of the survey revealed that 98% of the students considered that the course was a very useful tool to reinforce and integrate the knowledge in Physiology, and 100% thought that the course allowed them to apply the knowledge in Physiology in a practical setting, transferring what they had learned to the real situations of daily medical practice. In addition, 88.9% felt stimulated to search for additional bibliography and 77.8% stated that the course encouraged their independent study.

DISCUSSION

The goal of medical curricula is to provide graduates with the necessary tools to develop competencies and responsibilities to become good physicians in the eyes of patients and peers. (16) These competencies include not only physical examination skills but also the

Table 1. Physician office practice examiners' checklist. The examiner recorded the progression of the student in each area during every encounter.

Checklist	Yes	No
Introduction and Anamnesis		
1) Washes hands before contact with the patient.		
2) Introduces him/herself and greets the patient.		
3) Asks about patient's name, age and cause of consultation.		
a) Asks about smoking habits (duration, amount of cigarettes, type of exposure).		
5) Asks about personal smoking history (when he/she quit, habit duration, among others).		
6) Calculates correctly pack-years.		
7) Asks about diet characteristics (type, frequency and distribution of food in meals, alcohol intake).		
8) Asks about the practice of physical activities (type, time, frequency).		
9) Asks about the personal history of cardiovascular disease (HT, DBT, DLP, AMI, Stroke).		
10) Asks about the family history of cardiovascular disease (HT, DBT, DLP, AMI, Stroke) and age of deaths, if pertinent.		
11) Asks about current medications.		
Anthropometric Evaluation		
12) Asks the patient to undress leaving only the minimum clothes (without jewelry, shoes, etc.)		
13) Checks that the patient stands on the center of the weight scale platform.		
14) Asks the patient to stand in the upright position for each measurement, if pertinent.		
15) Performs the Tanner maneuver (displaces the chin upwards).		
16) Calculates BMI correctly.		
17) Identifies the iliac crests, the inferior edge of the costal margin and locates the intermediate point between them.		
18) Places the tape measure correctly, all the way around the waist.		
Blood Pressure Measurement		
19) Asks about situations which may modify BP values (coffee intake and/or smoking within the last 30 min).		
20) Asks the patient to sit down in a correct position and place the arm so that the elbow crease is at the heart level.		
21) Palpates the brachial pulse in the inner edge of the biceps muscle.		
22) Places the inferior edge of the cuff 2 cm above the crease of the elbow and positions the rubber blade over the brachial artery.		
23) Places the stethoscope diaphragm or bell directly over the brachial artery, just below the inferior edge of the cuff.		
24) Palpates the radial pulse while inflates the cuff 20-30 mm Hg above the SBP determined by palpation.		
25) Deflates the cuff at a rate near 2-3 mm Hg per second.		
Score Estimation and Test End		
26) Has written the information about anamnesis and physical examination.		
27) Has ordered laboratory/complementary tests.		
28) Calculates patient's Framingham score correctly.		
29) Explains the patient about his/her cardiovascular risk.		
30) Recommends the patient specific modifications to reduce the cardiovascular risk (diet, physical examination, quit smoking).		
31) Washes hands after saying goodbye to the patient.		
Observations:		

Table 2. Survey adjusted for the detection of acceptance/motivation of the initial guided reading, interest of the final debate with experts and level of self-esteem and sense of duty achieved.

Encounters attended:	No	A little	Yes	A lot
Did you find the course entertaining?				
Did the course encourage your independent study?				
Did the couse encourage you to read aditional material?				
Do you feel you might use what you have learned in real situations of medical practice?				
Was the course useful to reinforce the knowledge of physiology learned in the regular course?				
Was the course helpful to use the knowledge of physiology in a practical scenario?				
Have the teachers played the role of tutors for developing your skills?				
Have the teachers demonstrated their competence to educate?				
Have the teachers been motivators in the learning process?				

*This examination was used as pre-test and post-test to compare student's theoretical knowledge and correlate them with the results of the checklist.

Table 3. Written examination (taken at day 1 and at the end of the course). We corrected the examination using failure criteria for each answer*

CARDIOVASCULAR PRIMARY PREVENTION Competency-Based Course: Questionnaire	Name Date
1. Which is the leading cause of death in middle-aged patients (in industrialized countries)?	
2. How are cardiovascular risk factors classified? Mention all the risk factors you know and place them within the classification.	
3. Is it possible to calculate the risk of developing coronary artery disease? What is the benefit of "calculating the risk"?	
4. What is the difference between absolute risk and relative risk?	
5. In your opinion, what is the most important clinical consequence of developing atherosclerosis?	
6. What effects do tobacco smoke produce on endothelial function? Which are the consequences?	
7. What does pack/year mean? How is it calculated?	
8. How long does it take an ex-smoker's cardiovascular risk to be the same as that of someone who never smoked?	
9. Mention five target organs in HT:	
10. Stratify BP values of a patient with systolic BP of 150 mm Hg and diastolic BP of 95 mm Hg according to the classification of the JNC VII.	
11. How does HT modify the myocardial oxygen supply and uptake? Why?	
12. What type of exercise would you recommend to a patient with HT? Why?	
13. Mention the effects of aerobic exercise on the lipid profile (HDL-C; LDL-C; TOTAL CHOLESTEROL; TG.	
14. What kind of food should be included in the diet of a patient with dyslipemia ?	
15. Is high waist circumference more dangerous than high hip circumference? Explain.	
16. What is the underlying mechanism for the development of HT in insulin resistance?	

*This examination was used as pre-test and post-test to compare student's theoretical knowledge and correlate them with the results of the checklist.

development of attitudes and values to interact with patients and, essentially, of critical reasoning skills which include making observations, self-questioning and formulating and testing hypotheses. All these skills constitute an inseparable part of medical care. We think it is difficult to teach these competencies outside the natural environment constituted by physician's office, ward and lecture room.

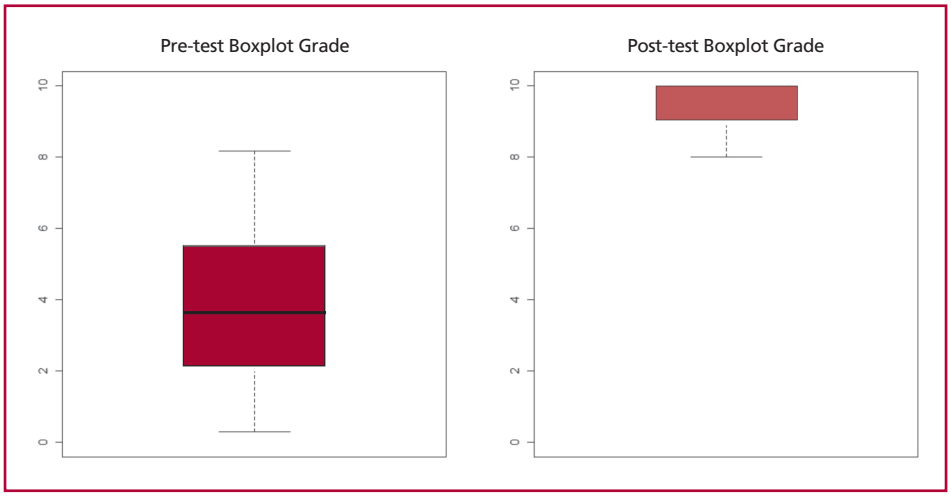

Fig. 1. Distribution of the pre-test and post-test variables.

It is very difficult for undergraduate students to build these skills, and even the use of clinical cases are also ineffective triggers because students are unable to evoke pictures of real patients from those written cases. In this sense, the lack of training in clinical examination prevents students from using standardized patients (real or simulated) as tools of motivation and contextualization for the study of Physiology. For us, the lack of a vertical integration between Physiology and Internal Medicine may be due to this factor.

The growing gap between basic and clinical disciplines, particularly in discipline-oriented curriculum, has generated the need for educational tools in order to contextualize, integrate, motivate and encourage students in the active learning of the most relevant concepts of professional practice. (4, 16) Problem-based learning (17) is a component of the integrated medical curriculum. Clinically oriented physiology teaching (18, 19) and early introduction of clinical medicine have been incorporated as other learning strategies. (20) In contrast with these, which use scenarios from where students generate questions, search for relevant information, debate and draw conclusions, Hudson et al. (21) have developed case-based teaching tutorials introducing the evaluation of physiological variables (like vital signs) among the students to provide important medical skills and encourage their participation and commitment.

The use of scenarios, clinical vignettes or clinical cases, which represent pathophysiological states, has been questioned by few teachers of Physiology, (22) as they promote a disease model of medicine instead of relating physiology with health and health promotion. Although the physiological mechanisms involved to adapt to pathological conditions are the same that take place in a healthy patient ,and the reality of daily medical practice is more related to disease than to health in adults, this observation is important due to the relevance and impact of prevention of diseases in public health. (6, 23, 24)

In agreement with this perspective, our goal was to use the acquisition of competencies in primary prevention using easy physical examination capabilities (vital signs, anthropometrics, blood pressure measurement) and calculating a few indices (body mass index, Framingham score) to establish cardiovascular risk in healthy patients. (9) Experience with healthy standardized patients can help undergraduate students build self-awareness in the interaction with patients, motivate them and make them feel a part of the healthcare system. (23) This motivation allows using cardiovascular risk factors as triggers for the study of endothelial and cardiovascular physiology. In this context, students learn easily and acquire significant knowledge while developing skills in cardiovascular primary prevention, a competence that sixth-year students lack. The results of our evaluation demonstrated that undergraduate students attending few encounters learned and progressed in their activities of independent study - they developed a medical skill.

Interestingly, although primary prevention is an important item in the professional profile of medical graduates, (6, 24) the competences in preventive medicine are not clear in the undergraduate medical curriculum. It is difficult to measure this deficit due to the low number of tests taken by sixth-year students and the bias associated with the fact that these students attend a high complexity center; yet, a trend exists which should be thoroughly studied.

We are developing two complementary modules to provide a vertical integration for secondary prevention in coronary artery circulation and ventricular function and dysfunction. At the same time, other modules are being developed for primary prevention in other systems to fulfill the same goals achieved in the cardiovascular area. In this way, an integrated medical curriculum will be generated based on competencies in primary prevention with the double aim of integrating physiology with internal medicine and, thus, developing a strong link with public health

and community health.

CONCLUSIONS

This analysis allowed the identification of a high percent of deficient questions. Although the quality index of one of the tests was acceptable, both tests should be improved.

RESUMEN

Desarrollo de competencias de prevención primaria cardiovascular en el pregrado: una forma de integración vertical de la fisiología

La Sociedad Argentina de Cardiología, en los procesos de Certificación y Recertificación de Especialistas, implementa exámenes escritos de selección múltiple. Dos observadores independientes revisaron las 200 preguntas utilizadas en dos exámenes (A y B) realizados durante 2009. Se usó el Índice de Calidad de Galofré; este instrumento toma en cuenta 10 criterios que se deben considerar en la redacción de las preguntas de selección múltiple y establece una escala de 1 a 5 puntos según la cantidad de defectos de construcción que tenga la pregunta. El valor máximo de calidad posible es 5. La media aritmética de los valores de calidad de las preguntas expresa el Índice de Calidad del examen en su totalidad.
Se encontró que el 30% de las preguntas tenían muy buena calidad técnica (valores de calidad 4 y 5); cerca del 40% eran preguntas aceptables (valor de calidad 3) que se deberían mejorar y el 30% eran inaceptables (valor de calidad 1 y 2).
El examen A tiene un Índice de Calidad de 2,15 y el examen B, de 3,21. En ambos exámenes se encontró que los defectos más frecuentes en la redacción de las preguntas eran la falta de viñeta (caso clínico o problema) y la exploración de conocimientos sólo a nivel de memoria o recordación de datos aislados. Se concluyó que sería conveniente constituir en la Sociedad Argentina de Cardiología un grupo de trabajo permanente para revisar y mejorar las preguntas y armar un banco de ítems.

Palabras clave > Educación médica - Preguntas de selección múltiple - Evaluación de la calidad de los exámenes

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