Performance in cardiac examination and diagnostic accuracy after training medical students with simulators vs. patients

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Abstract

Introduction: To ensure a good medical preparation and reduce the risk of mistakes, different methods and techniques for the development of clinical practice are used; cardiac examination skills decrease along the time. For this purpose simulation is implemented on the teaching process, and the impact of it on performance of cardiac auscultation should be assessed.

Objective: We aimed to compare 4th-year med students' performance and diagnostic accuracy during the cardiac examination, before and after training.

Method: The sample comprised forty-six 4th year med students randomized into two groups. One group was trained with cardiac simulators and the other with patients exclusively. We assessed their ability to perform a cardiac examination and the diagnostic accuracy by using a standardized assessment checklist for a cardiac examination and then performed a statistic test to compare both groups' performance.

Results: There was a difference between both groups' initial scores of 2 decimals (7.1 and 7.3 on a 0-10 scale). After training, we found that the patients' trained group had an average score of 8.6 while the simulators trained group had an average score of 8.8 and higher diagnosis accuracy.

Conclusions: Clinical simulation and patient training are two different ways of achieving the same goal. There are many reports that claim simulation is best to train medical students, but in this report, we did not observe a statistical difference among them. This is not however, a disadvantage. Clinical simulation offers better learning experience, shown as a tendency in the scores and better diagnostic accuracy. The lack of significant difference between the simulator/patient groups can be explained by a small sample size.

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Desempeño en la exploración cardiaca y precisión diagnóstica de estudiantes de medicina posterior al entrenamiento con simuladores vs. pacientes

Resumen

Introducción: Para asegurar una buena preparación médica y reducir el riesgo de errores, se utilizan diferentes métodos y técnicas para el desarrollo de la práctica clínica. Las habilidades de exploración cardiaca disminuyen con el tiempo, por lo cual se ha implementado la simulación en el proceso de enseñanza y debe evaluarse su impacto en el rendimiento de la auscultación cardiaca.

Objetivo: Nuestro objetivo fue comparar el rendimiento y la precisión diagnóstica de los estudiantes de medicina de cuarto año durante el examen cardiaco, antes y después del entrenamiento.

Método: La muestra estuvo compuesta por cuarenta y cinco estudiantes de medicina de cuarto año asignados al azar en dos grupos. Un grupo se entrenó con simuladores cardiacos y el otro exclusivamente con pacientes. En las diferentes pruebas, evaluamos su capacidad para realizar un examen cardiaco y la precisión del diagnóstico mediante el uso de una lista de verificación de evaluación estandarizada para un examen cardiaco. Luego realizamos una prueba estadística para comparar el desempeño de ambos grupos.

Resultados: Hubo una diferencia entre las puntuaciones iniciales de ambos grupos de 2 decimales (7.1 y 7.3 en una escala de 0 a 10). Después del entrenamiento, encontramos que el grupo entrenado de pacientes tenía una puntuación media de 8.6, mientras que el grupo entrenado con simuladores tenía una puntuación media de 8.8 y una precisión diagnóstica más alta.

Conclusiones: La simulación clínica y el entrenamiento del paciente son dos formas diferentes de lograr el mismo objetivo. Hay muchos informes de que la simulación de reclamos es mejor para capacitar a los estudiantes de medicina, pero en este informe no observamos una diferencia estadística entre ellos. Sin embargo, esto no es una desventaja. La simulación clínica ofrece una mejor experiencia de aprendizaje, que se muestra como una tendencia en los puntajes y una mejor precisión diagnóstica. La falta de diferencia significativa entre los grupos de simulador/pacientes puede explicarse por un tamaño de muestra pequeño.

INTRODUCTION

The teaching-learning process in medicine is based on the teaching of theory and the development of practical skills that begin with the auscultation of a healthy patient to later identify and treat those with some pathology. Initially, the teaching was a tutorial from the teacher to the student, working directly with patients[1].

However, at present, the demand for health services leads to a decrease in the time devoted to each consultation[2], making the student unable to fully implement their auscultation skills or obtain feedback from their Professor, in addition, the clinical scenarios are not standardized and sometimes there is little availability of patients with cardiac pathologies. If we add to the above that the margin of error in medicine carries a significant risk for the patient, requiring safer systems for its development[3], it is evident that some medical schools began to look for alternatives to traditional teaching, employing other methods and techniques for the development of clinical practice such as simulated patients, simulators and some others use more than one.

Clinical simulation has shown advantages over

other methods since it imitates aspects of reality in medical care, confronting students with the problems they will have to deal with on a daily basis in their medical practice. It also facilitates the repetitive practice of the skills until their total acquisition as well as their evaluation and immediate feedback on their performance is allowed[4].

Since the late 1960s, simulation has been used to teach cardiac auscultation using a manikin, as well as the recording of heart sounds[5,6]. The usefulness of simulation to carry out practices of this type is undoubted. However, the interaction that students have with patients or with simulated patients cannot be fully supplemented since it encourages the student to empathize with the patient and also gives him more confidence when performing the physical examination than when doing it. with a simulator[7,8], for this reason, some schools have developed hybrid models with simulated patients and electronic components attached to their torsos for the auscultation of different heart sounds[9].

Despite the use of all these strategies, it has been documented that the cardiac examination skills in students decrease after having taken the subject in school[10,11], partly attributed to the fact that in some medical schools, simulation is used to introduce students to heart sounds rather than to perform repeated practice, and the impact of the use of this teaching tool on the performance of cardiac auscultation is not measured[12].

In this article, in order to measure the impact that the use of simulation has on the performance of cardiac auscultation, we compare the diagnostic accuracy and the scores obtained by students trained with simulators vs. patients, finding that both techniques are equivalent for the development of auscultation skills, however, those who used simulators achieved greater diagnostic precision.

METHOD
We invited sixty-nine 4th-year students from a medical school, to take part in this longitudinal study.

Baseline assessment
After consent, the students were randomized into two groups according to the teaching method to be used (A: simulators and B: patients). Every student was given a unique study number to guarantee anonymity.

An Initial test was performed on a cardiac simulator (Kyoto, Kagaku model M8481-8 high quality sounds, 88 cardiac sounds and palpable pulses) using a validated check list to evaluate a proper cardiac examination using 16 items **(see appendix)**. Three of them are specific for the identification of abnormal cardiac examination findings. Plus, the diagnostic accuracy of the 5 more common cardiac conditions seen in the clinical environment (aortic and mitral insufficiency, mitral, aortic, and tricuspid stenosis). This frequency was measured by a dichotomous "yes or no" question for a right diagnosis given **(figure 1)**.

Intervention phase
To have a proper learning experience, both groups took a theoretical lesson on cardiac examination skills by a certified cardiologist with teaching experience, during which they reviewed basic cardiovascular assessment, the cardiac cycle, and most frequent cardiovascular pathologies observed in the Hospital, as mentioned above. At the end of the lessons, they were provided with didactic material, including recordings of cardiac sounds of the pathologies seen in class **(figure 2)**.

Next, group A had 2 hours of practical lessons on cardiac examination skills using cardiac simulators (Kyoto, Kagaku model M8481-8) in the school of medicine, while group B had 2 hours of practical training on the field on cardiac examination skills in live patients at the hospital, both with the same certified cardiologist who taught them how to introduce themselves, put the patient on a right position for an auscultation protocol and emphasizing on the points of auscultation and identification of normal and abnormal heart sounds **(figure 1)**.

Final test
Once teaching lessons were finished, both groups went into a final test on the cardiac simulator, using the same checklist as for the initial test and assessed by the original teacher. This session was videotaped to have proper feedback **(figure 1)**.

Ethical considerations
All the participants freely gave their informed consent to participate on this study. They were explained
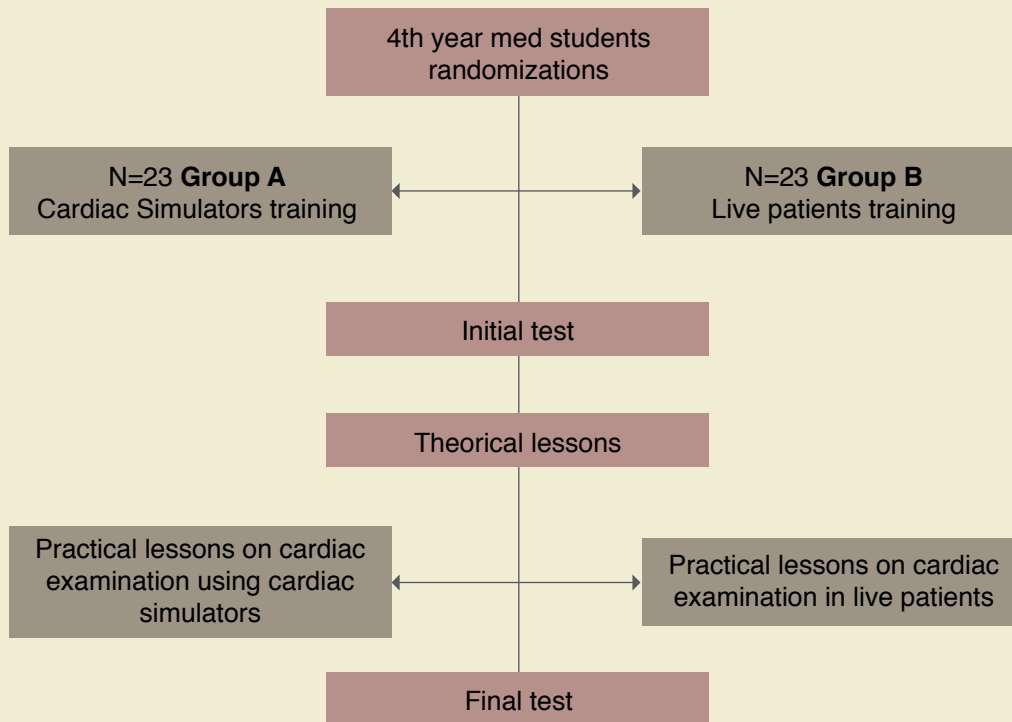
Figure 1. Study design

4th year med students randomizations

N=23 **Group A**
Cardiac Simulators training

N=23 **Group B**
Live patients training

Initial test

Theorical lessons

Practical lessons on cardiac examination using cardiac simulators

Practical lessons on cardiac examination in live patients

Final test

Figure 2. Learning experience in cardiological simulation

Learning experience

Situation
- Cardiology is a medicine branch that requires expert knowledge and prior experience. Simulation allows to obtain both of this element in a reproducible, reliable and easily evaluable way.
- Students will have a simulator/patient whit a pathology commonly found in cardiology primary attention. They will have to show their skill and knowledge in the clinical environment.

Purpose
- Provide medicine students with the tools to provide quality medical attention. Using medical simulation tools to emulate, as real as possible, cardiological examination.

Competences
- Solving cardiological problems.
- Enhance experience in clinical cardiological exploration, as well as diagnosing the most common cardiological pathologies.

Products
- Students will have a better understanding of the cardiological clinical exploration, both using clinical simulation or practicing in real patients in the hospital context.
- Students will have more experience diagnosing cardiological diseases, based on experience.

Table 1. Measures of central tendency from scores obtained after the initial y final tests in both groups

	Initial test patients	Final test patients	Initial test simulators	Final test simulators
Minimum	2,5	7,5	4,3	7,5
25% Percentile	5,6	8,1	6,2	8,1
Median	6,8	8,7	7,5	8,7
75% Percentile	8,7	9,3	8,1	8,7
Maximum	10	10	8,7	9,3
Mean	7,0	8,7	7,2	8,5
Std. Deviation	2,0	0,8	1,0	0,5
Std. Error of Mean	0,43	0,18	0,22	0,12

* The scale used was taken from the "CESIP, Centro de Enseñanza de Simulación de Posgrado, DICiM Universidad Nacional Autónoma de México UNAM" Mexico City, previous authorization.

that their participation was completely voluntary and that they could quit on the study whenever they wished so.

This study was based on Helsinki's declaration statements and approved by the Research Ethics Committee of the (Name not shown in order to keep anonymity on peer-review process) (Act. Number 0220092018).

STATISTICAL ANALYSIS

We carried out an analysis by using measures of central tendency for the results of the scale, also, Mann Whitney U test was used to calculate the differences between the study groups, considering significant a p-value <0.05.

RESULTS

After inviting 69 4th year medical students to participate in this study, only 46 decided to take part providing consent; all of them completed the study. 67% of them were men and 33% were women. The average age of these students was 23 years old, with a range between 21 and 26 years old.

These students had already taken cardiology lessons during their college formation.

Students were distributed randomly into two groups (A and B) and then went into an initial test, before having any training (except for one of their curricula backgrounds) and one week after having it. We performed an initial and a final test to evaluate two parameters. The first one was "Cardiac examination skills" and the second was "diagnostic accuracy".

The results are as follows:

Cardiac examination skills
Initial test
The mean of the group that was going to be trained with cardiac simulators (A), was 7.1/10 points, while the mean of the group that was going to be trained with live patients (B) was 7.3. No statistical difference was found meaning a similar baseline level of knowledge in the cardiac examination **(table 1)**.

Final test
To determine if there was a significant difference in the results of the cardiac examination test taken by the students depending on the teaching technique and after the students were trained, they went into a final test.

The mean of the group that was trained with simulators, was 8.8/10 points, while the mean of the group trained with patients was 8.6. No statistical difference was found, however, since the scores show a tendency to an increased result in simulation training, we think that a bigger sample size could help in making this difference clearer **(table 1)**.

Although there was not a significant difference in the test results between training techniques, we found a significant difference between the initial and the final test results of both groups **(figure 3 and 4)**.
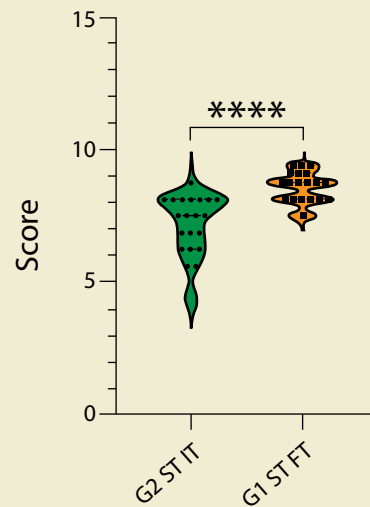
Diagnostic accuracy
Finally, we evaluate the capability to give the correct diagnosis (diagnostic accuracy) by the students

Figure 3. Comparison between initial and final means scores obtained by the students trained with patients. Mann Whitney U test p<0.05 (G1 PT IT: Group 1 patients trained Initial test. G1 PT FT: Group 1 patients trained Final test.)
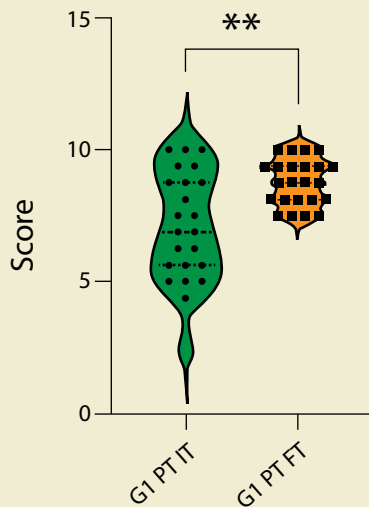
Figure 4. Comparison between initial and final means scores obtained on the tests by the students trained with simulators. Mann Whitney U test p<0.05. (G2 ST IT: Group 2 simulators trained Initial test. G2 ST FT: Group 2 simulators trained Final test.)

during the cardiac examination test between both groups. Despite both groups improved the diagnostic accuracy after training, the group trained with cardiac simulators had the highest frequency of correct diagnosis (16 out of 23 *vs*. 13 out of 23 students).

Financial disclosure summary

The authors disclose no conflict of interest regarding this research. On the other hand, the funding of this project comes from the budget for education and equipment acquisition of the (name not shown to keep anonymity on the peer-review process).

DISCUSSION

Simulation is a particular type of modeling. As a particular way of understanding the world, it can simplify our understanding of it, making it more reproducible, educational, and risk-free. Borrowing from Aristotle "the things we have to learn before we do, we have to do", in this article we try to understand the difference between the use of clinical simulators and patients in medical education, specifically for cardiology training.

It is documented that cardiology examination skills decrease over time in medical students and doctors, hence, the importance of continuous medical practice, which can be carried out using simulators. The simulators allow clinical exploration protocols to be repeated to gain competencies, improve performance, acquire, and master skills, and ultimately become an expert[13,14].

In our study, both groups have already had previous training in cardiology according to the study plans of the medical school, however, at the end of the study, we observed better performance in the cardiac examination regardless of the teaching method used, which suggests that the technique does not affect the acquisition of skills, it is the deliberate and continuous practice that strengthens the acquisition of skills so that the responses to a medical problem become intuitive and systematized. Then the medical student or the doctor can respond appropriately without thinking twice, which has a positive impact on reducing the risk of errors[15,16].

The foregoing agrees with previous reports by Issenberg et al (2002) who applied tests in a cardi-

ology review course for internal medicine residents using simulation technology vs. deliberate practice[17], finding a significant difference between the grades obtained before and after the course.

Kern and Mainous reported that students who received cardiac examination skills training with standardized patients plus a cardiopulmonary simulator performed significantly better than the control group. However, the results of our study showed that there is no significant difference in the performance of medical students trained with patients versus those trained with cardiac simulators.

This could be explained by the difference in the number of participants since Kern and Mainous compared many participants (control group: 281 and 124 study groups) versus 46 medical students in our study[18].

In the present study, in addition to observing an improvement in student performance before and after training, we also observed a better diagnostic accuracy, which suggests that the learning objectives were achieved.

These results contrast with the findings of Gauthier, Johnson, et al (2019) who report that there are no differences in the mean scores of the Objective Structured Clinical Examination (OSCE) using real patients[19].

However, the use of standardized scenarios and simulation learning objectives helps to ensure the quality of medical practice since all students can learn the same thing, which is not always possible within a hospital or clinic since pathologies from one patient to another may have variations. Not to mention, sometimes patients don't want to be examined by a medical student or a group of them.

Simulation alone cannot guarantee the acquisition of clinical skills by the user if he does not have the opportunity for deliberate and constant practice[20,21], which is why McKinney, Cook, Wood, et al (2013) suggest that future studies should focus on comparing the key features of instructional design and establishing the effectiveness of simulation-based medical education (SBME) in comparison with other educational interventions[22].

In addition to the above, and based on the results of this study, we recommend combining a teaching program using cardiac simulators and training with real or standardized patients, trying to involve students and with special attention to debriefing, since it is considered which is the most important part of training[23]. All this would favor the teaching-learning process, considering that teachers would act as guides or facilitators working on a problem-solving model since this develops skills for their resolution[24].

This is challenging as simulation is still under development in many countries for many reasons; some think it is a time-consuming teaching method, some students find it difficult to get involved with simulators and even some teachers may be reluctant to use them[25], however, it is worth its implementation, since it is true what the simulator says adage: "Never the first time in a patient"[13], therefore we propose a general guideline to create a successful simulation experience that should be complemented with a future evaluation of the learning experience referred by the student **(figure 5)**.

LIMITATIONS

A limitation on the present study was the number of students participating on it, since a larger number could point the results to another direction.
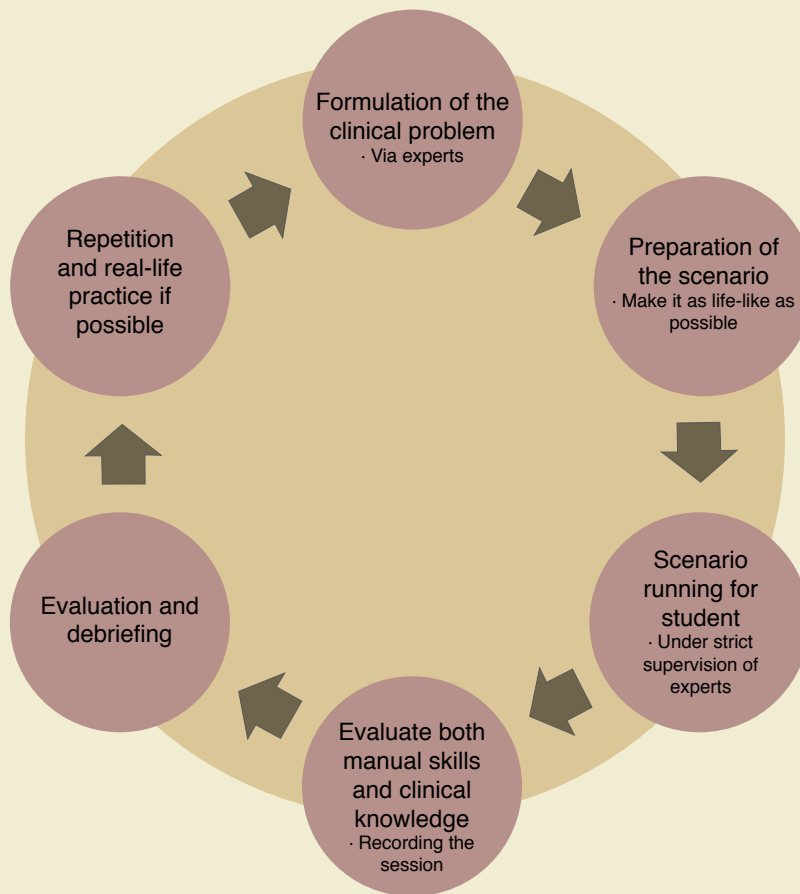
CONCLUSIONS

Clinical simulation and patient training are two different ways of achieving the same goal. There are many reports that claim simulation is best to train medical students, but in this report, we did not observe a statistical difference among them. This is not however, a disadvantage. Clinical simulation offers better learning experience, shown as a tendency in the scores and better diagnostic accuracy **(figures 3 and 4)**. The lack of significant difference between the simulator/patient groups can be explained by a small sample size.

AUTHORSHIP

- LGM: Design of the work, interpretation of data and Drafting of the work.
- JCG: Acquisition and analysis of data.
- ARA: Acquisition and analysis of data.
- RMCB: Acquisition and analysis of data.
- CPCA: Conception and work design. Drafting and revising content of the manuscript.

Figure 5. Proposed process for clinical simulation in medical education. Each step must be carefully planned and prepared beforehand if the simulation is to be believable. Repetition is key for the learning process

ACKNOWLEDGMENTS

PREVIOUS PRESENTATIONS
None.

FINANCIAL DISCLOSURE SUMMARY

CONFLICT OF INTERESTS

The authors disclose no conflict of interests regarding this research. 🔍

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