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## Evaluation of a Simulation Program for Management of Cardiovascular Emergencies in Pregnant Women

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### Authors' Contributions:

Mechal H, Benmalek R, Habbal R and Mouhaoui M, All authors contributed equally to this work

## 1. Abstract

**1.1. Introduction:** Medical education worldwide is undergoing a pedagogical renovation movement; medical simulation is one of the revolutionary educational tools whose aim is to improve the medical knowledge, technical and non-technical skills of health professionals, while ensuring patient safety. Many studies have dealt with the contribution of simulation in cardiology, however no studies have been done on the management of cardiovascular emergencies in pregnant women by simulation. The purpose of our work is to evaluate a simulation-based educational training program on cardiovascular emergencies in pregnant women by comparing it to a "traditional" training program and to assess the students' satisfaction with this teaching method.

**1.2. Methods:** We conducted an experimental, comparative, randomized and multicentric study on 60 medical students ( $\geq$  6th year), the study was executed in 6 steps: started with a presentation of the educational program, then a pre-test, followed by a theoretical training session on cardiovascular emergencies in pregnant women, a randomization of students into two groups, according to whether they had benefited or not from simulation sessions Have been realized before taking a post-test.

**1.3. Results:** We selected 57 students: 29 in group 1 (SIM +) and 28 in group 2 (SIM-), both groups were comparable regarding their level of medical studies, hospital training in cardiology or gynecology and prior participation at simulation sessions. The pre-

test results were comparable for both training groups (8.69 +/- 3.44 for group 1 versus 8.41 +/- 2.46 for group 2). The progression of the marks between the pre-test and the post-test was significant ( $p < 0.001$ ) for both training groups, however a better progression of the marks in group 1 (SIM +) compared to group 2 (SIM-) has been observed ( $p = 0.001$ ).

**1.4. Conclusion:** This preliminary study has demonstrated the considerable interest of medical simulation as an innovative teaching tool in training on cardiovascular emergencies in pregnant women and its added value compared to "traditional" training programs.

## 2. Introduction

Medical education worldwide is undergoing a pedagogical renovation movement; Several questions arise about the evaluation of training systems, in terms of content, relevance and quality of methods educational (1). Medical education seeks to integrate the notion of performance and management of risks in care, which explains the development of innovative teaching methods (2), which allow better acquisition of skills, improved quality and safety of care, while practicing patient-centered medicine.

Among the curricular innovations that meet this need, figure simulation-based medical learning (3). Medical simulation is one of the revolutionary educational tools whose aim is to improve the medical knowledge, technical and non-technical skills of health professionals, while ensuring patient safety. Many studies have dealt with the contribution of simulation in cardiology, however

no studies have been done on the management of cardiovascular emergencies in pregnant women by simulation. The purpose of our work is to evaluate a simulation-based educational training program on cardiovascular emergencies in pregnant women by comparing it to a "traditional" program.

### 3. Methods

We conducted an experimental, comparative, randomized and multicentric study on 60 medical students having a level equivalent or superior to the 6th year of general medicine.

The study was executed in 6 steps shown in (Figure 1).

During the 1st step, the suggested educational program was presented to the students, information was given concerning the duration, the schedule and the objectives of the program, program objectives, as well as the nature of trainers, the teaching and assessment methods.

The 2nd step consisted of a written exam [pre-test], that included 20 single or multiple choice questions, relating to cardiovascular emergencies in pregnant women. The students were not aware that this pre-test would take place and no prerequisites were required. The pre-test was graded with a score / 20. The aim of this step was to do a global screening of the level of theoretical knowledge of the students before they benefit from the developed educational program.

The 3rd step consisted of theoretical training for all the students who participated in the study. It lasted 3 hours. This theoretical training was in the form of interactive lectures on the main cardiovascular pathologies and emergencies during pregnancy. The goal of this step was to reactivate and homogenize the knowledge of the students, before moving on to medical simulation.

In the 4th step, a randomization was carried out using the Epi info software 6. A total of 30 students out of 60 were drawn by the software and were automatically placed in Group 1 that would benefit from the medical simulation before the assessment, and the rest of the participants were placed in Group 2 that was not going to benefit from the medical simulation before the assessment. The goal of this step was to split the initial group into two comparable groups [group 1 (SIM +) and group 2 (SIM-)] in order to be able to study the impact of medical simulation on the development and progression of knowledge of a group compared to the other, and thus assess the contribution of medical simulation as an educational tool compared to a "classic" educational program.

During the 5th step, the students went through a stage of hybrid medical simulation using a high fidelity female pregnant mannequin (NOELLE®, Goumard scientific) (Figure 2) piloted by a SimMan® monitor (Figure 3). Four scenarios were proposed, Scenario 1: Hypertensive emergency in the form of hemorrhagic cerebrovascular accident (hemorrhagic stroke) in pregnant women. Scenario 2: Peri-partum cardiomyopathy (Meadows syndrome). Scenario 3: Severe mitral stenosis with rapid atrial fibrillation in <http://acmcasereports.com>

a pregnant woman. Scenario 4: Cardiovascular arrest caused by massive pulmonary embolism in a pregnant woman.

Each scenario was structured and described in a technical document, specifying: the educational objectives, the nature of the simulated situation, the roles of the trainers, the preparation of the simulation room, the programming of the mannequin in terms of vital constants and 'physical aspect, the evolution of the scenario, the assessments and the various examinations that may be requested, as well as a "check list" or evaluation grid, allowing the performance of the learners to be assessed throughout the course of the scenario. This step took place in 3 phases: a briefing, scenario and debriefing phase. The briefing consisted of familiarizing the students with the equipment (possibilities and limits of the mannequin), presenting the patient's file, the context and the environment (circumstances, accompanying persons, etc.). During this step the trainer explained to learners and observers the course of the simulation session in order to make learners feel comfortable and create an environment conducive to learning. Then each scenario took place in the presence of two instructors; the 1st acted as the conscious patient through a microphone and interacted with the students during the scenario, the 2nd took care of the adjustment of the monitor parameters, while adapting to the decisions made by the students; and a facilitator who helped the simulation students to access the equipment, to the various drugs, and to the progress of the scenario if necessary (example: the use of a defibrillator). The various complementary exams were given to the students on request by the facilitator. The students took turns participating in the scenarios, with the participation of 3 students each time. Each simulation phase lasted between 10 and 15 minutes, followed by a debriefing of 20 to 30 minutes. The scenarios were assessed on the basis of a pre-established assessment grid for each scenario and which was discussed during the debriefing.

The final (6th) step consisted of an assessment by written exam for all students [SIM + group and SIM- group]. The questions were identical to those of the pre-test. This post-test was also rated with a score / 20. The test was given to the students of group 1 (SIM +) after the simulation and to the students of group 2 (SIM-) before the simulation, which made group 2 (SIM-) a control group during our study. The progress between the pre-test and post-test in each group and between the two groups was evaluated using the average gain in scores between pre-test and post-test. The aim of this step was to assess the progression of students' theoretical knowledge with or without simulation.

Statistical analysis: The data were analyzed using SPSS 20 software. The quantitative data were expressed in means +/- standard deviation. Qualitative data were expressed in frequencies. Statistical analysis was univariate using Student's t test for quantitative data and Chi-square test for qualitative data. The risk of error  $\alpha$  was set at 5% and the statistical tests were considered significant when the p value was <0.05.

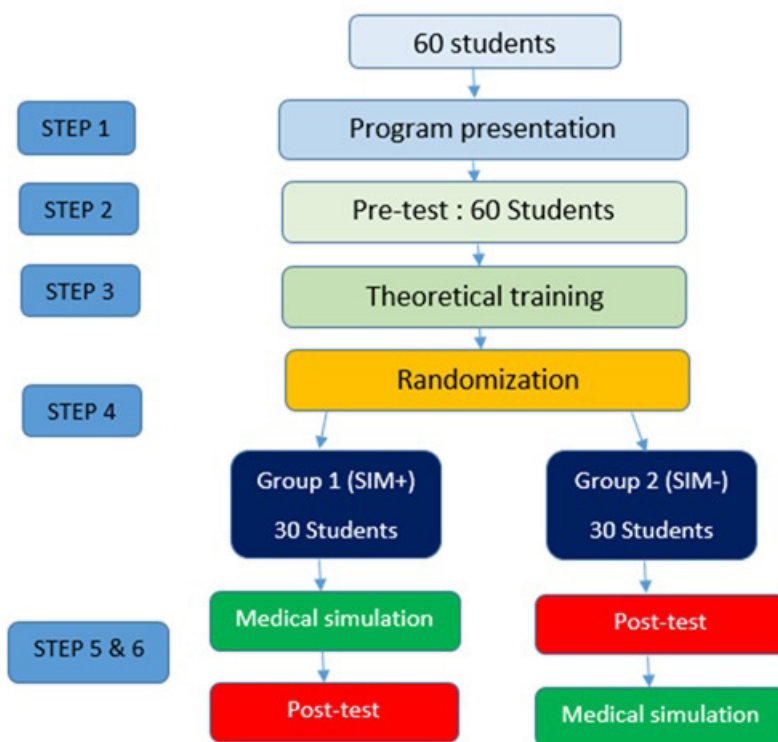


Figure 1: Study steps



Figure 2: Simulation model NOELLE® (Goumard scientific) and the simulation environment

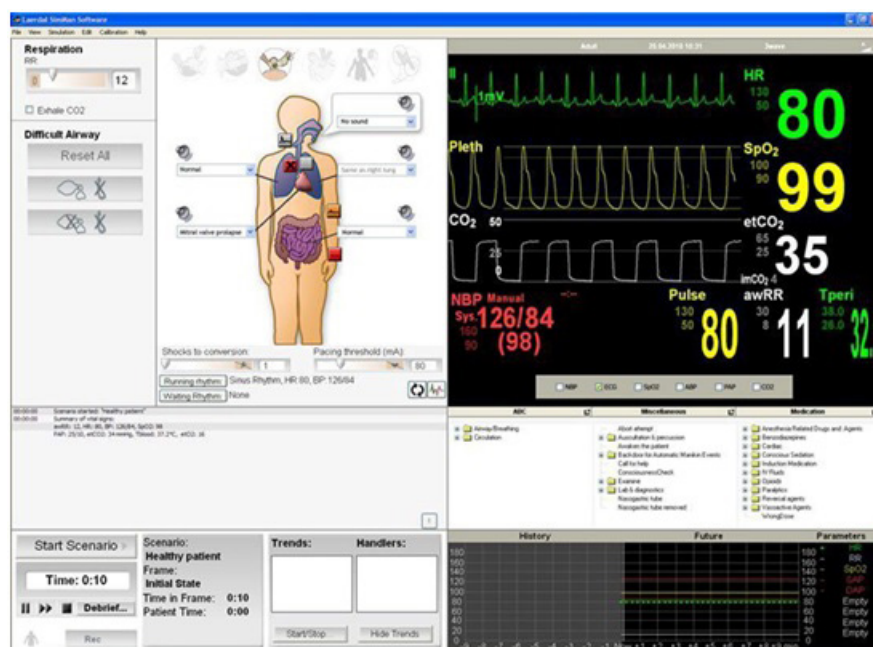


Figure 3: SimMan® Monitor with respiratory and hemodynamic parameters for the simulated scenario

#### 4. Results

This work involved 60 students, among them there were 2 withdrawals and 58 students eventually participated in the study, with a participation rate of 96.66%.

The average age of the participants was 23.29 (+/- 1.20) years and the majority of participants (70.7%) were female representing a Gender Ratio M/F of 0.41. Among the 58 participants, 49 students (84.5%) were in the 6th year of medical studies. 56.9% have already attended a simulation session and only 24.1% have already participated in a simulation session.

We compared the two groups formed in terms of demographic properties, and mainly in terms of elements that may influence the results of the training, such as the level of studies and the participation of students in previous simulation sessions. The two groups were comparable: the mean age was 23.48 (+/- 1.55) years in group 1 and 23.10 (+/- 0.67) in group 2 ( $p = 0.234$ ). The female sex represented 62.1% in group 1 and 79.3% in group 2 ( $p = 0.149$ ). There was no significant difference between the 2 groups in terms of level of study, the 6th year students represented 86.2% of group 1 and 82.8% of group 2, ( $p = 1$ ). The percentage of students who have already attended a simulation session at least once was 58.6% in group 1 and 55.2% in group 2 ( $p = 0.791$ ). The students who declared having already actively participated in a simulation session represented 37.9% of group 1 and 34.5% of group 2, with no significant difference between the two training groups ( $p = 0.785$ ).

The participation rates of students to the pre-test and the post-test were 100% for both training groups. The pretest mean was 8.69 (+/- 3.44) / 20 in group 1 (SIM +) and 8.41 (+/- 2.46) / 20 in group 2 (SIM-), without significant difference between the 2 training groups ( $p = 0.727$ ). The post-test mean was 16.24 (+/- 2.31) / 20 in group 1 (SIM +) and 13.18 (+/- 2.60) / 20 in group 2 (SIM-). The <http://acmcasereports.com>

average gain in scores between pre-test and post-test for Group 1 (SIM +) was 7.55 (+/- 3.08) points, with a significant progression between the pre-test and the post-test ( $p < 0.001$ ) and was 4.75 (+/- 2.73) points for Group 2 (SIM-) with also a significant progression between the pre-test and the post-test ( $p < 0.001$ ).

However, the comparison of progression between group 1 and group 2 has shown a better evolution of scores between the pre-test and the post-test in group 1 who benefited from the simulation compared to group 2 who did not benefit from the simulation ( $p = 0.001$ ). The correlation between the pretest-posttest deviation and the training groups was also significant ( $p = 0.001$ ). Summary of comparison of results between group 1 et 2 is shown in Table 1.

**Table 1:** Comparison between Group 1 (SIM+) et Group 2 (SIM-)

|   | <b>Group 1</b><br>N = 29 | <b>Groupe 2</b><br>N=29 | <b>p value</b> |
|---|--------------------------|-------------------------|----------------|
| <b>Age</b>  | 23,48 (+/- 1,55)         | 23,10 (+/- 0,67)        | 0.234          |
| <b>Female</b>   | 62.10%                   | 79.30%                  | 0.149          |
| <b>Male</b>   | 37.90%                   | 20.70%                  |                |
| <b>6th year students</b>                                | 86,2%                    | 82,8%                   | 1              |
| <b>Attendance to a previous simulation</b>              | 58,6 %                   | 55,2%                   | 0.791          |
| <b>Active participation in a previous simulation</b>    | 37,9%                    | 34,5%                   | 0.785          |
| <b>Pre-test score</b>                                   | 8,69 (+/-3,44)           | 8,41 (+/-2,46)          | 0,727          |
| <b>Post-test score</b>                                  | 16,24 (+/-2,31)          | 13,18 (+/-2,60)         |                |
| <b>Score progression between Pre-test and Post-test</b> | 7,55 (+/3,08)            | 4,75 (+/- 2,73)         | <0.001         |

## 5. Discussion

Simulation is considered a revolutionary educational tool in health science education, it is a training method based on the reproduction of clinical scenarios, experiential learning, reflective practice and feedback. The different situations offered in simulation enable students to develop and acquire procedural and technical knowledge, to work on the management of rare or frequent events (especially in interdisciplinarity) and the management of resources in crisis situations. A simulation program is a training and / or practice analysis and / or research program that uses simulation. It may, depending on the themes and objectives, include other methods (theoretical courses, practical workshops, etc.). In all cases, the place of simulation in this program is determined by the educational added value provided compared to other existing methods [4].

The learning objectives aim to improve medical knowledge, technical and non-technical skills such as communication, leadership and teamwork, always with a vision of zero risk for patients "never the first times on a patient". Simulation can be used as a training tool as well as an assessment tool. It can target a wide range of learning objectives (cognitive, psychomotor or affective ...). [5]

Among the various specialties open to this technological breakthrough, cardiology, has also adopted this tool to develop training programs for its specialists. Several studies witness to the contribution of simulation-based training programs in cardiology, particularly in the field of cardiological explorations such as transesophageal echocardiography, interventional cardiology and electrophysiology [6]. However, most of the simulation studies in cardiology to date focus only on critical cardiovascular situations outside the gestational state.

Cardiovascular causes currently represent the leading non-obstetric cause of maternal mortality. The management of heart disease during pregnancy poses two different problems: on the one hand, the occurrence of decompensation of pre-existing heart disease during pregnancy caused by physiological changes induced by pregnancy. On the other hand, the diagnosis and treatment of de novo heart disease during pregnancy [7].

In the absence of adequate care, these pathologies can have a rapidly fatal evolution. Their early recognition is therefore essential, because it determines their prognosis. The complexity of medical situations and the mother-child duality make multidisciplinary coordination essential [8]. Cardiovascular pathologies in pregnancy, due to the multidisciplinary management and the specificity of the diagnosis and treatment, make this situation perfectly suited to teaching by simulation.

The debriefing provides realistic and educational feedback to students' questions, decisions and actions. This method of teaching is a modern and a more effective tool than traditional theoretical training, both for the acquisition of technical and non-technical skills. Simulated exercise sessions, even of short duration, allow a significant improvement of participants' results. A markedly higher progression among students trained by a simulation program is noted compared to students trained by a "traditional" program. Simulation is not intended to replace bedside education, nor theoretical or faculty education, but it is an essential complement. It is a powerful tool which makes it possible to complete the clinical experience by reinforcing cognitive learning, by increasing the possibility of practicing diagnostic reasoning and therapeutic gestures, and by integrating the notion of a healthcare team, without threats to the safety of patients.

## 6. Conclusion

Medical education has been imprisoned for a long time in theoretical and traditional educational programs that do not allow future health professionals to achieve adequate learning goals. The rise of simulation-based educational programs is a revolution in medical education. It has established itself in recent years as an essential training method for all health professionals by creating an environment where technology is at the service of education. This practice speeds up the learning curve of "saving gestures" and provides a learner-centered environment where the student can develop his potential at an appropriate pace.

## 7. Competing Interests

The authors declare no competing interest.

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