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Stress levels during emergency care: A comparison between reality and simulated scenarios☆,☆☆

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ABSTRACT

Purpose: Medical simulation is fast becoming a standard of health care training throughout undergraduate, postgraduate and continuing medical education. Our aim was to evaluate if simulated scenarios have a high psychological fidelity and induce stress levels similarly to real emergency medical situations.
Materials and Methods: Medical residents had their stress levels measured during emergency care (real-life and simulation) in baseline (T1) and immediately post-emergencies (T2). Parameters measuring acute stress were: heart rate, systolic and diastolic blood pressure, salivary α-amylase, salivary interleukin-1β, and State-Trait Anxiety Inventory score.
Results: Twenty-eight internal medicine residents participated in 32 emergency situations (16 real-life and 16 simulated emergencies). In the real-life group, all parameters increased significantly ($P < .05$) between T1 and T2. In the simulation group, only heart rate and interleukin-1β increased significantly after emergencies. The comparison between groups demonstrates that acute stress response (T2 – T1) and State-Trait Anxiety Inventory score (in T2) did not differ between groups.
Conclusions: Acute stress response did not differ between both groups. Our results indicate that emergency medicine simulation may create a high psychological fidelity environment similarly to what is observed in a real emergency room.

1. Introduction

Medical simulation is fast becoming a standard of health care training throughout undergraduate, postgraduate and continuing medical education [1,2]. High-fidelity simulation (HFS) is an essential tool for training health care providers in virtually every field of medicine. The primary benefit of using HFS as an educational tool is that learners can practice on multiple levels (cognitive, procedural and affective) in a protected environment, where the risk of error will not harm real patients [3–5].

Most rapidly adopted in acute care specialties [6], HFS-based training is used in approximately 90% of emergency medicine residencies in the U.S. [7]. In this setting, where various procedures and treatments can lead to serious adverse events, residents and educators are often challenged with balancing patients' safety and education goals [8].

Education and practice in emergency medicine have long been perceived as stressful endeavors [9]. Significant levels of stress have been well documented in medical trainees. Potential sources of stress are many and include working under conditions of sleep deprivation, managing family life in a busy schedule, overload from coursework, and demands related to caring for critically ill patients [10-12].

Although there has been significant research into the effects of chronic stress on both physical and mental health of physicians, there has been little research into the effects of acute stress on performance [13]. Results of clinical studies from different medical settings were ambiguous in regards to the relationship of acute stress and medical performance [14].

Performance in critical situations can be either enhanced or impaired, depending on the cognitive appraisal of the situation, which happens through individual's perception of demand and resources [15,16]. Although a certain degree of stress may improve task performance and medical skills [17,18], stress can become a threat when the perceived demands outweigh the individual's coping resources. This situation, as demonstrated in previous researches, may result in lower performance [19–24]. Thus, depending on an individual's perception of demands and available resources, the response to acute stress may vary.

Regardless of whether acute stress causes worsening or improvement in performance, it is not well known if simulation can provide realistic scenarios that evoke psychological stress similarly to that of real medical emergencies. Although increasing literature has shown that HFS is able to induce high levels of acute stress when compared to control conditions [25,26], only one study compared the stress level between simulated scenarios and real-life clinical care in the emergency room. In this study, Quilici et al. [27] found that stress measures during the simulated scenario were higher than those measured in real situations. However, stress

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measures in the simulation setting were performed in an *Advanced Trauma Life Support* exam and the fact that residents were being evaluated, with the possibility of failing the exam, may have contributed independently to increased stress levels, as indicated in earlier studies [10].

In the present study, we compared the acute stress levels of second-year volunteer internal medicine residents in real emergency care and in simulated emergencies. Our aim was to evaluate if simulated scenarios have a high psychological fidelity and induce stress levels similarly to real emergency medical situations.

2. Materials and methods

2.1. Study design

This is a prospective observational study, performed between February 2011 and December 2013, at the Emergency Department of the Hospital das Clínicas (University of São Paulo's Medical School) and at the Simulation Center of the FMUSP in São Paulo, Brazil. This study was approved by the Ethics and Research Committee of the University of São Paulo (CAPPesq, project number: 0629/10).

2.2. Participants

We invited all second-year internal medicine residents to voluntarily participate in this study. The inclusion criteria was the acceptance to participate in the study. Exclusion criteria were: pregnancy, infections of any kind, disease of the immune system, endocrine or metabolic diseases and use of any kind of medication (except for oral contraceptives).

Participants who had their stress levels measured in the emergency room (real setting), were on a 12-hour daytime duty in the emergency department. Participant's stress levels in simulated scenarios were accessed in a simulation center (simulation setting) during clinical ward practice. The participation of the same resident in both simulated scenarios (A and B) was allowed. Written informed consent was obtained from all the participants includes in the study.

2.3. Real setting

Data collection started before entering the emergency room (ER), between 08:30 and 09:00 AM. The resident (only one per day) was placed sitting at rest for 5 min and their baseline (T1) stress levels were measured. Immediately after the first clinical emergency care situation (T2), stress levels were measured again. During the period between T1 and T2, the participant remained with a heart rate monitor.

For this study, we considered the following clinical emergency care situations: (*a*) shock (any kind); (*b*) acute respiratory failure requiring invasive ventilation or non-invasive positive pressure ventilation; (*c*) decreased level of consciousness requiring endotracheal intubation; (*d*) cardiac arrest and (*e*) arrhythmias with hemodynamic instability.

The end of the emergency care situation (T2) was considered when: (*a*) patient's mean arterial pressure was greater than 65 mm Hg; (*b*) oxygen saturation by pulse oximetry was greater than 90% after confirmed endotracheal tube position; (*c*) there was return of spontaneous circulation maintained for at least 5 min or when terminated efforts and death was confirmed, and (*d*) patient was hemodynamically stable after therapeutic measures.

2.4. Simulated setting

In the simulation center, between 01:30 and 02:00 PM, residents (4 per simulation) were placed sitting at rest for 5 min and their baseline (T1) stress levels were measured. Before starting the scenario, participants were oriented for 15 minutes by a physician facilitator about the simulation room setup, manikin features and simulation methodology. Immediately after the end of simulated emergency scenario (T2), stress levels were measured again. During the period between T1 and T2, participants remained with a heart rate monitor. The end of the emergency scenario (T2) was considered according to the same criteria as the real-life emergencies. Regardless of the clinical management of the situation, the scenario was finalized 30 minutes after its start.

The simulated emergency scenarios were performed using a high fidelity computer-based manikin simulator, with the possibility of remote control of vital signs (SimMan, LAERDAL). All medications and equipment required during the clinical scenarios were available and the simulation room was set up similarly to a real-life emergency room. Standardized physiologic responses to anticipated management steps were programmed into each scenario and activated by a physician facilitator. When an unexpected management maneuver was performed, the physiologic response was entered manually by the monitoring physician. The facilitator remained in a 1-way mirrored glass control room.

The scenarios used were elaborated by 3 experienced simulation facilitators of the Clinical Emergency Discipline of the FMUSP and tested for 2 years before this study. In the scenarios, 2 residents played the role of nurses and the remaining 2, the role of physicians. The following simulated emergency scenarios were applied:

Scenario A: A 55-year-old patient was admitted to the ER with precordial pain, having been evidenced right ventricular myocardial infarction. During care, patient develops cardiogenic shock and third-degree atrioventricular block, requiring volemic expansion, vasoactive drug and a transcutaneous cardiac pacing.

Scenario B: A 26-year-old patient was admitted to the ER with signs and symptoms of cocaine intoxication and develops unstable ventricular tachycardia. Patient presents hypotension and acute pulmonary edema, requiring electrical cardioversion and invasive ventilation.

2.5. Stress level measurement

Heart rate (*HR*): This parameter was continuously measured using a heart rate monitor (FT2Model, Polar Electro Oy., Kempele, Finland). The maximum heart rate during emergency care (real-life and simulation) was recorded from the watch system. HR response was calculated as the difference between the maximum HR during emergency care and the baseline HR in T1. For HR response, the maximum HR value was considered as T2.

Systolic blood pressure (*SBP*): this measure was obtained using an aneroid sphygmomanometer (Model Shock Resistant, Welch Allyn Inc., Skaneateles Falls, NY, USA) and the mean of 3 measures was considered. SBP response was calculated as the SBP difference between T2 and T1.

Diastolic blood pressure (*DBP*): this measure was obtained using an aneroid sphygmomanometer (Model Shock Resistant, Welch Allyn Inc., Skaneateles Falls, NY, USA) and the mean of 3 measures was considered. DBP response was calculated as the DBP difference between T2 and T1.

Salivary analyses: Saliva samples were obtained in T1 and T2 by a specific swab (Salivette®, SARSTEDT AG & Co, USA) placed under the tongue for 2 min. The samples were centrifuged at 1500*g* for 15 minutes at 4°C and stored in a freezer at – 80°C. The participants were required to abstain from eating, drinking (except water) and brushing teeth 1 hour before the material collection. Stress responses were calculated as the difference of salivary α-amylase (AA) and interleukin (IL)–1β between T2 and T1. In the salivary samples, we measured:

- Salivary α-amylase by a kinetic colorimetric test (α-amylase Salivary Assay Kit, SALIMETRICS Inc., State College, PA, USA). AA is a marker of acute psychological stress in healthy adults [28], commonly used in researches involving clinical simulation [29].
- Salivary IL-1β by an immunoenzymatic method (Salivary IL-1β Kit, SALIMETRICS Inc., State College, PA, USA). IL-1β is a marker recently used to measure acute stress [30,31].

State anxiety scale (*STAI-s*): this is one of the 2 components of the State-Trait Anxiety Inventory Score (STAI). STAI-s is a widely used self-report scale for measuring state anxiety [32], translated and validated for Brazilian Portuguese [33]. The inventory has 20 items and the score range is 20 to 80, with higher scores indicating grater anxiety.