

## Article

# Autonomic Stress Response of Nurse Students in an Objective Structured Clinical Examination (OSCE)

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**Abstract:** The aim of the present research was to analyze the autonomic stress response of nursing students in a nursing Objective Structured Clinical Evaluation (OSCE). We analyzed, in 41 s-year nursing degree students ( $20.1 \pm 2.3$  years), modifications in heart rate variability (HRV) to monitor the autonomic stress response before, during and after the 18 different scenarios of a complete OSCE. Heart rate mean response of nurse students was consistent with an anticipatory anxiety response at the beginning of the OSCE, showing a sympathetic nervous system activation, but HRV parameters show contradictory results. The most stressful OSCE station was the CPR maneuver, the stress response varying according to the station's demands.

**Keywords:** stress; autonomic modulation; HRV; nurse; students; OSCE



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## 1. Introduction

Since the Bologna declaration was established, the competencies acquisition learning process has been introduced in the European Union high education frame. This type of learning is more active, promotes critical thinking, and focuses on teaching and evaluation methods. New evaluation processes have been developed to assess whether students acquire the abilities and skills required for their careers. Thus, new techniques have been created, such as conferences, clinical stays, seminars, simulations. . . [1]. From this perspective, it is possible to assess if students have acquired theoretical knowledge, as well as competences, when they develop and put into practice these learning methods [2]. One of the techniques used with this aim is clinical simulation, more useful in biomedical degrees, where students are involved in an artificial context that is related to a clinical environment. Some of the advantages for health training are the ability to create a space similar to reality, and a controlled and safe context that allows students to practice and train some skills. This method is as useful for students to learn, as it is for professors to assess their learning process. One of these techniques is the Objective Structured Clinical Examination (OSCE) that consists of a simulation system, composed by different stations, with simulated patients where students can practice any kind of skill [3].

However, these evaluations and learning methods could also have some drawbacks. They could represent a stressful environment for students, where they must develop all their abilities to cope with the unknown and uncertainty, and this could affect their academic performance [4]. This stress response is modulated by the autonomic nervous system, showing a high sympathetic system activity, triggering low memory capacity, difficulty concentrating, difficulties with executive functions and decision making, low learning capacity, and low self-confidence [4,5]. There are some other fields, such as military or academic ones, where it has been analyzed how repeated exposure to the stressor produces a habituation process triggering a high parasympathetic activity, and therefore, reduces the stress response [6,7]. Autonomic modulation of stress response can be directly measured through devices that analyze Heart Rate Variability (HRV) [8].

OSCE is one of the most appropriate learning methods for nursing students, due to the huge capacity to create a precise and realistic scenario, as well as the possibility to acquire the required competencies. This technique is useful to increase students' self-confidence in their clinical stays but it can also be a stressful event due to its complexity and the limited time to work it out. Students present more stress at the beginning of the OSCE due to the unfamiliarity with the method [9].

The aim of the present research was to analyze the autonomic stress response of nursing students while they undertake an OSCE examination. The initial hypotheses were: (i) students would show a habituation process at the end of the OSCE, decreasing the sympathetic modulation. (ii) Autonomic stress response would vary according to the demands of each OSCE station.

## 2. Materials and Methods

### 2.1. Participants

We analyzed 41 volunteer second-year nursing degree students (29 females and 12 males;  $20.1 \pm 2.3$  years). All the students had the same experience prior to facing the clinical sceneries; therefore, they all shared the same starting point and conditions regarding the acquisition of competences. All the procedures were conducted following the Helsinki Declaration (as revised in Fortaleza, Brazil, 2013), all the participants filled in an informed consent form before starting the research and all the procedures were approved by the University Ethic Committee (CIPI/18/074).

### 2.2. Procedure

HRV was analyzed in an OSCE composed of the following 18 scenarios: M1. Pre moment: 10 min before the OSCE. M2. Interprofessional (IPE): the student was required to interact in the presence of a doctor and manage the roles and functions with regard to the patient. M3. Recovery and reading contextualization of the next scenario: student break time and data reading. M4. Mobilization: carrying out posture changes of a bedridden patient. M5. Recovery and reading contextualization of the next scenario: student break time and data reading. M6. Break: free time. M7. Recovery and reading contextualization of the next scenario: student break time and data reading. M8. CPR: practicing a cardiopulmonary reanimation. M9. Recovery and reading contextualization of the next scenario: student break time and data reading. M10. BP + EKG: To conducting an arterial tension and electrocardiogram tests on a simulated patient. M11. Recovery and reading contextualization of the next scenario: student break time and data reading. M12. Nutritional evaluation: assessing the nutritional state and any risk factors of a simulated patient. M13. Recovery and reading contextualization of the next scenario: student break time and data reading. M14. Respiratory evaluation: assessing the respiratory function of a simulated patient. M15. Recovery and reading contextualization of the next scenario: student break time and data reading. M16. Venipuncture: practicing the vein puncturing technique on simulated arms. M17. Recovery and reading contextualization of the next scenario: student break time and data reading. M18. Post moment: 10 min after the OSCE.

We recorded HRV with a validated device PolarV800 and analyzed the data with the Kubios HRV software (version 2.1, Biosignal Analysis and Medical Imaging Group, University of Kuopio, Kuopio, Finland). A very low threshold artifact correction was applied to the data to clean the RR sample, and the FFT spectrum (Welch's periodogram) was used to analyze the Frequency Domain variables. The following HRV variables were obtained: HR: heart rate; PNN50: percentage of differences between normal adjacent R-R intervals greater than 50 ms; RMSSD: the square root of the average of the sum of the differences squared between normal adjacent; LF: low frequency waves that are related with the sympathetic system; HF: high frequency waves that are related with the parasympathetic system; LF/HF ratio: low frequency waves and high frequency waves ratio; SD1: short-term variability of the HRV; SD2: long-term variability of the HRV. Parameters related with high sympathetic nervous system activation are a high HR, LF,

SD2. The ones related with the parasympathetic activation are RMSSD, a high PNN50, HF, high LF/HF, SD1.

### 2.3. Statistical Analysis

The SPSS statistical package (version 22.0; SPSS, Inc., Chicago, IL, USA, Ill.) was used to analyze the data. Normality and homoscedasticity assumptions were checked with a Kolmogorov–Smirnov test. Differences in HRV between the OSCE situations were analyzed using a MANOVA with samples as a fixed factor and with a Bonferroni post hoc. The Effect Size was tested by the  $\eta^2$ . Finally, a bivariate correlation analysis between all the study variables was performed using a Pearson correlation analysis. The level of significance for all the comparisons was set at  $p \leq 0.05$ .

## 3. Results

The MANOVA results showed significant differences between the situations analyzed (Wilks lambda = 0.638;  $F = 2.104$ ;  $p = 0.000$ ;  $\eta^2 = 0.055$ ). We found that HR was significantly higher in the pre (M1) than in the break situation (M6) ( $115.5 \pm 3.2$  vs.  $97.7 \pm 3.2$  bpm;  $p = 0.019$ ), and the respiratory evaluation (M14) ( $115.5 \pm 3.2$  vs.  $97.6 \pm 3.2$  bpm;  $p = 0.018$ ). HR was also significantly higher in the CPR scenario (M8) than in the break situation (M6) ( $117.9 \pm 3.2$  vs.  $97.7 \pm 3.2$  bpm;  $p = 0.002$ ), nutritional evaluation (M12) ( $117.9 \pm 3.2$  vs.  $100.6 \pm 3.2$  bpm;  $p = 0.032$ ), respiratory evaluation (M14) ( $117.9 \pm 3.2$  vs.  $97.6 \pm 3.2$  bpm;  $p = 0.002$ ), and the post OSCE moment (M18) ( $117.9 \pm 3.2$  vs.  $100.2 \pm 3.4$  bpm;  $p = 0.031$ ).

RMSSD in the pre moment (M1) were higher than in the recovery and reading situation D (M9) ( $58.5 \pm 4.5$  vs.  $34.2 \pm 4.9$  ms;  $p = 0.049$ ), recovery and reading number situation E (M11) ( $58.7 \pm 4.5$  vs.  $33.4 \pm 5.0$  ms;  $p = 0.036$ ), respiratory evaluation (M14) ( $58.7 \pm 4.5$  vs.  $34.7 \pm 4.5$  ms;  $p = 0.036$ ), recovery and reading number situation F (M13) ( $58.7 \pm 4.5$  vs.  $28.5 \pm 4.7$  ms;  $p = 0.001$ ), venipuncture scenario (M16) ( $58.7 \pm 4.5$  vs.  $34.3 \pm 4.5$  ms;  $p = 0.028$ ), and also higher than in recovery and reading situation G (M15) ( $58.7 \pm 4.5$  vs.  $33.3 \pm 4.8$  ms;  $p = 0.023$ ). PNN50 was significantly higher in pre moment (M1) than in recovery and reading situation F (M13) ( $18.3 \pm 1.9$  vs.  $7.9 \pm 2.2\%$ ;  $p = 0.034$ ) (Figure 1).

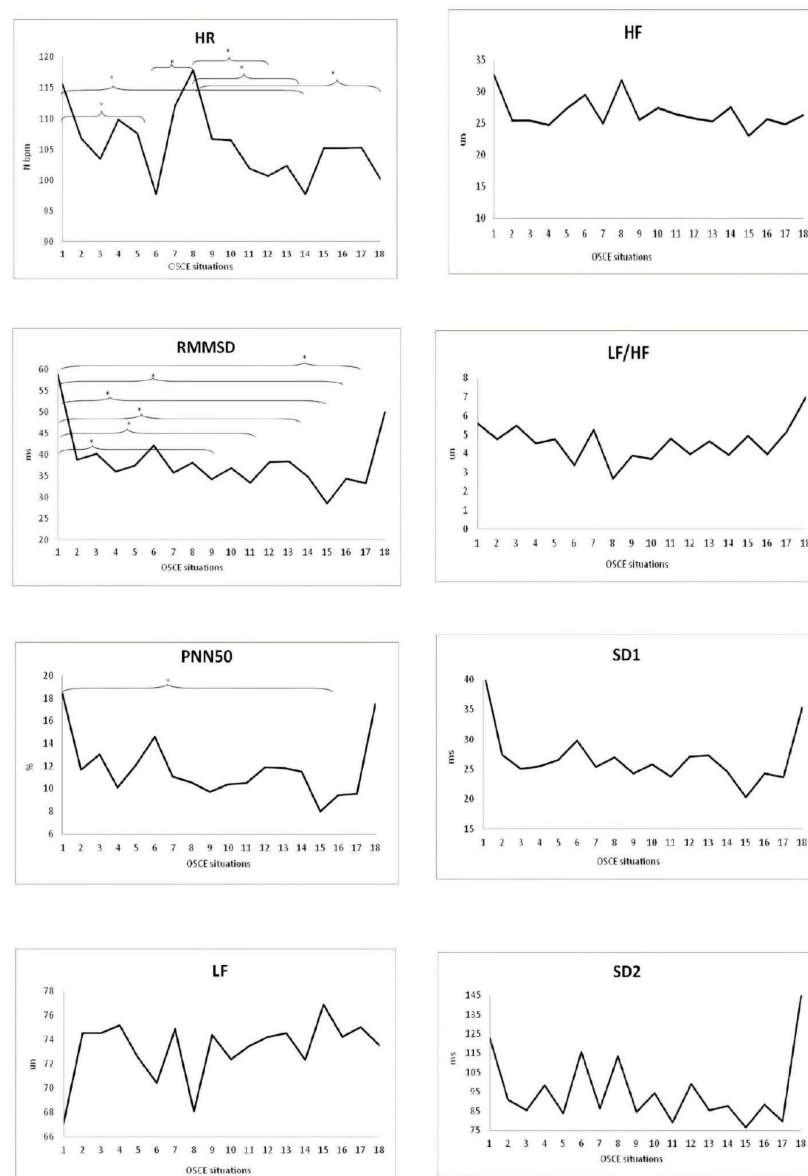
## 4. Discussion

The aim of the current research was to analyze the autonomic stress response of nursing students while they undertook an OSCE. The first hypothesis was partially confirmed, since an activation of the sympathetic nervous system was evaluated at the beginning of the OSCE, being reduced through the following stations. The second hypothesis was also confirmed because stress response varies regarding OSCE station demands and complexity.

We found significantly higher HR mean values at the beginning of the OSCE, physiological response according to an increased sympathetic modulation. This result suggests that students presented an anticipatory anxiety response at the beginning of the OSCE. Previous studies associated this response to unknown and threatened events, and in the present case the fact that the academic grade of students depends on the separation of the OSCE also acts as stressor. These results were also observed in other research conducted with first year nursing students undertaking an OSCE [5], with final year physiotherapy students in their final degree dissertation [8], and with final year psychology students in an OSCE [10]. Anticipatory anxiety was also observed in other contexts where subjects must be exposed to novel and stressful situations, such as soldiers in combat maneuvers [11], parachuting [12] and extreme sports events as ultraendurance races [13].

Mean HR was also significantly higher on the CPR station (M8) compared with the break moment (M6), nutritional assessment (M12), respiratory assessment (M14), and post OSCE moments. The CPR station and the pre OSCE moment were the most stressful situations evaluated. The CPR maneuver is one of the most difficult procedures in the health environment because it requires a large dexterity and agility to perform it in a really short time period. It is necessary to have some years of experience in an emergency service, and to receive some further training to acquire a high level of competency with

this maneuver [14]. Moreover, it is a technique that carries a big emotional charge since the life of a person depends on the ability of the practitioner [15]. Therefore, it is normal to find that the CPR was the most stressful station for the inexperienced students evaluated. Although it is also important for the patient's health the, nutritional assessment was not as stressful as other scenarios for students since it was not necessary to perform it as urgently as CPR for example. In this regard, it could be perceived as easier since students just need to calculate the body mass index, anthropometric measures, fill in questionnaires, etc. [16]. A similar response was seen in the respiratory assessment that requires analysis of different parameters, such as oxygen saturation, pulmonary ventilation, auscultation, etc., where students presented a lower stress response than in the CPR [17].



**Figure 1.** Heart rate variability variables during the different Objective Structured Clinical Examination scenarios.

Analyzing the HR mean, we found a reduction in sympathetic nervous system activation in the break (M6) and the post OSCE moment (M18). However, it was not observed in recovery moments. In this regard, analyzing HRV parameters, we found contradictory information in the PNN50 and RMSSD response. Values of these temporal domain variables were higher at the pre moment (M1), which reflects a parasympathetic activity

closer to a basal state, a fact that contradicts the HR means results. In other research with psychology students, it was found that the HRV parameters sensitive to identify the autonomic modulation were PNN50, RMSSD, SD1, SD2, and HF [18], and with physiotherapy students, the sensitive parameters were PNN50, RMSSD, SD1 and SD2 [19]. With athletes' sample, PNN50, RMSSD, and HF were the parameters sensitive to identify the autonomic modulation [20], and with military population the parameters were RRSD, and RR interval mean [21]. The contradictory [22] information obtained could be related with the sensibility difference to identify the autonomic modulation with the present population. More research is needed to better understand the HRV modifications in different contexts and populations.

Regarding the habituation response of students, we found that a maintained sympathetic modulation was observed analyzing the three HRV domains used. The RMSSD and PNN50 presented high values before the OSCE and were decreasing until the last scenarios, finally increasing after the OSCE. Regarding the frequency domain, we found decreased HF values and increased LF, showing non-significant modifications during the entire OSCE. Finally, the non-linear domain variables of SD1 and SD2 presented similar tendency to RMSSD and PNN50, showing high values before and after the OSCE, and lowing during the OSCE. This lack of habituation response was also evaluated in experienced nursing students in a real context as a hospital clinical simulation [23], pharmacy students in real chemistry laboratory practices [24], Ph.D. students in the defense of their doctoral project [25], and physiotherapy students in the defense of their final degree dissertation [26]. This non adaptive response to the stressful context of the OSCE could be related with a non-adaptive psychological profile and the low experiences with the specific stressor [8].

The principal limitation of the present research was the lack of evaluation of hormonal stress response, the lack of characterization of the psychological profile of students and the lack of randomization of OSCE scenarios. Specifically, this last one could have a direct effect on psychophysiological response of students [27,28], but we cannot modify this fact since it was a real evaluation, and we did not have permission to modify the procedure. Future research might seek to address these limitations.

As a practical application of the results obtained in the present research, we can highlight the importance of increasing the exposure of students to this type of professional simulation situation and the inclusion of pedagogical contents that allow the development of skills and competences that can be applied to real professional contexts. These facts would help the student to decrease the psychophysiological stress response by increase the perception of controllability of an eliciting context, enabling a more adaptive psychophysiological response.

## 5. Conclusions

Heart rate mean response of nurse students was consistent with an anticipatory anxiety response at the beginning of the OSCE, showing sympathetic nervous system activation, but HRV parameters show contradictory results. The most stressful OSCE station was the CPR maneuver, varying the stress response according to the station demands.

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**Data Availability Statement:** All the data are in the manuscript.



**Conflicts of Interest:** The authors declare no conflict of interest.

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