

The stress experienced in an emergency medical service (EMS): A descriptive study

Manuel Pons Claramonte^{a,b}, Sergio Nieto Caballero^{a,c}, Damián Escribano Tortosa^d, Maria Dolores Contreras-Aguilar^d, Jose Joaquin Ceron Madrigal^d, Juan José Hernández Morante^a, Ana Nicolas Carrillo^a, Manuel Pardo Rios^{a,c,*}, Esther Chicharro-Luna^e

^a Health Sciences Faculty, UCAM Universidad Católica de Murcia, Spain

^b Emergency Medical Service (EMS) of Valencia Region, Spain

^c Emergency Medical Service (EMS) of Murcia Region, Spain

^d Interdisciplinary Laboratory of Clinical Analysis (INTERLAB-UMU), Department of Animal Medicine & Surgery, Veterinary School, Regional Campus of International Excellence 'Campus Mare Nostrum', University of Murcia, Campus de Espinardo, 30100 Espinardo, Murcia, Spain

^e Department of Behavioural Sciences and Health, Nursing Area, Faculty of Medicine, Miguel Hernández University of Elche, Institute of Health and Biomedical Research of Alicante (ISABIAL), Alicante, Spain

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ABSTRACT

Introduction: Stress, described as an adaptation of the body to an event, is a considerable problem among health workers, especially for those who work in emergency situations, as they very often have to face complex situations. It has been proven that stress affects the performance of health professionals, which is why it is interesting to measure it in these situations, to be able to know what methods to implement to reduce it in future events. Despite having previous measurements in healthcare personnel during clinical simulations, this study is relevant because stress has never before been measured in EMS professionals when performing their work.

Objective: To determine the acute stress experienced by professionals in an Emergency Medical Service (EMS) when handling five types of clinical emergencies. As secondary objectives, to determine if there were differences in the increases in stress in relation to sex, age, profession, team, and above all, type of emergency handled.

Method: The following were measured for the analysis: physiological (mean heart rate (HR), systolic (SBP) and diastolic (DBP) blood pressure), and biochemical (salivary alpha amylase (sAA) activity) markers, before (Basal) and after (Post-Stress) the interventions of 27 professionals from an EMS.

Results: In general, the results obtained showed significant differences between the baseline measurement of physiological and biochemical markers versus the post-exposure measurement. Some of the differences in stress levels in relation to sex and professional role are striking.

Conclusion: The determination of acute stress experienced by professionals from an EMS in a real emergency showed significant increases in the sAA enzymatic marker of acute stress. These results are the first data published in this regard, and could be used as a reference to follow in clinical simulation in the training of students and the training of nursing professionals.

Implications for clinical practice: Evidence based studies are needed to improve the education and training of emergency and intensive care professionals. The results from are a great step in the analysis of the real stress that professionals are subjected to when they handle different emergencies.

1. Introduction

The term stress was first defined by Selye in 1956 as an adaptive reaction of an organism against the demands from its medium [1]. Stress is an adaptive response of an organism against a physical or

psychological demand. The self-perception of stress appears when a subject cannot meet these demands [2]. A stressful situation initiates a neurohormonal activation system which include the increase of biochemical markers. One of the most-utilized biomarkers used to quantify stress is the activity of salivary alpha amylase (sAA) [3]. This is

* Corresponding author at: Health Sciences Faculty, UCAM Catholic University of Murcia, Murcia, Spain.

E-mail address: mpardo@ucam.edu (M. Pardo Rios).

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one of the main salivary enzymes that is secreted as a response to stimuli from the sympathetic nervous system [4] (SNS), so it is considered as the biomarker of choice in situations of acute psychologically-stressful stimuli [5].

Stress is a considerable problem among health workers, especially for those who perform their activity in emergencies, as they very often have to face complex situations that lead to stress [6]. It has been demonstrated that stress affects the performance of health professionals [7]. The unpredictable situations they face require the fast making of decisions, and stress can lead to the inadequate management of the threats against the life of a patient [8]. In the last few years, health sciences training programs have included the use of methodologies based on the participation in high-fidelity clinical situation scenarios [9]. There is a relationship between the stress generated through clinical simulation in emergency-based scenarios and the influence on the performance in an academic setting [10]. However, research is lacking on the levels of stress of these healthcare professionals in real situations of out-of-hospital emergencies handled by an Emergency Medical Service (EMS).

This study aims to shed light on the prevalence and severity of stress among EMS professionals worldwide, acknowledging the universality of stress in high-pressure environments and its critical impact on effectiveness and safety in patient care. By understanding these factors in a specific context, we seek to contribute to the international body of knowledge on stress management in emergency situations. The main objective of this work was to determine the increase in stress experienced by EMS professionals when handling real emergencies. The secondary objectives were to determine if there were differences in the increases in stress according to sex, age, professional category, and overall, as a function of the type of emergency handled.

2. Methods

2.1. Participants and ethical consent

The participants in this cross-sectional analytical study were all the 27 health professionals from EMS number 13 (UME Naval, Cartagena Murcia) belonging to the 061 management in Murcia (Spain), from Feb. 1st, 2022, to April 30th, 2023. For this, one of the 2 units in this region that perform neonatal transfers was randomly chosen. The effect size was estimated as Cohen's d of 0.8, considered large in the context of health sciences research. With a significance level of 0.05, using a large effect size based on the observed increase in sAA after the intervention and 27 participants, the calculated power was 82 %. All the staff of this unit participated in the study voluntarily and there was no loss of sample during the study. In this case, the selected unit was the MEU-13, based in Cartagena (Spain). The study was carried out in a single unit so as not to alter the normal functioning of the EMS from the Region of Murcia. The protocol was approved by the Ethics Committee from (blinded for review), with registration number CE022212, dated 12-25-2021.

The staff has an on-call schedule that lasts 24 h with a fixed team every 5 days, which starts at 8am. The health professionals are distributed into 5 teams composed of 4 members each (doctor, nurse, and 2 emergency medical technicians (EMT)). Likewise for the 4th-year (R4) resident medical intern (MIR) from the Family and Community Medicine. Thus, in some on-calls, we may find 5 health professionals.

The inclusion criteria were the following: (1) voluntary participation; (2) assistance in events in which advanced life support (ALS) techniques were performed. For this, five clinical situations were defined: Advanced Life Support in a cardiorespiratory arrest, Advanced Life Support (LS) (advanced management of an airway, manual or mechanical breathing support), caring for a severely traumatized patient (who needed immobilization), inter-hospital transfer of a critical adult or pediatric patient, and transfer of a critical neonatal patient; (3) not having experienced psychologically traumatic events that led to temporary sick leave due to these; and (4) not suffering from a disease or undergoing treatment that could interfere with the endocrine system.

Also, there was a set of conditions for the taking of samples: not having vacation in the last two weeks, and not being on-call in the prior 24–48 h.

2.2. Analysis of stress

2.2.1. Biochemical marker: salivary alpha amylase (sAA) activity

The basal and post-stress activity of sAA was determined for all the participants after finishing any of the five clinical situations defined in the inclusion criteria. The service was considered to have ended when the patient was transferred to the destination hospital or when the service ended with the death of the patient. At this time, the post-exposure sample was taken, always before leaving the unit in use again.

The saliva was obtained through a passive diffusion system into a tube, with an extraction time of 1 min. This procedure was carried out by the medical staff of the UME-13 team that was trained to collect the sAA saliva sample, so that there were no differences between the collections and to avoid any of the sample. The processing and analysis of the sample were performed following the same procedure as in previous studies [11]. The method had an inter-assay variation coefficient lower than 3 % and a linear regression coefficient of 0.992 [11].

2.2.2. Physiological markers: heart rate (HR), systolic blood pressure (SBP), and diastolic blood pressure (DBP)

The following physiological parameters were determined: HR, SBP, and DBP. For this, basal HR, SBP, and DBP were recorded at rest in a non-working day. The recording of the physiological variables after a stressful stimulus was performed after the end of the caregiving event considered in the inclusion criteria without delaying the actions of the unit, while the saliva sample was collected. For this, a Philips HeartStart MRx (Philips, Eindhoven, Netherlands) defibrillation monitor was utilized, with an immediate recording after the end of the intervention.

The measurement of these variables was carried out by the nursing staff of UME 13, as they are the ones with the most experience in this intervention, as they regularly perform it on the patients handled by this unit.

2.3. Statistical analysis

The data will be presented through the use of frequencies, means, and standard deviations. To study the effect of the different variables on the stress variables before and after the intervention, *Student's t-tests* were utilized for paired data, and a repeated means ANOVA was performed for the analysis of the factors (event, profession, years of experience, gender, etc.). Also, the possible influence or interaction of these variables was determined through a repeated measures ANCOVA. The *post-hoc* corrections for multiple analyses were performed with Tukey's test. The data were exported to the Microsoft Excel® program and analyzed with the SPSS v26 statistical software (SPSS Inc, Chicago, IL). The results were considered statistically significant when $p < 0.05$.

Table 1
Initial characteristics of the participants (n = 27).

Age (years)	45 ± 11 [40–49]
Experience (years)	2.1 ± 1.2 [1.6–2.5]
sAA (IU/L)	381.4 ± 341.8 [246.2–516.6]
SBP (mmHg)	124 ± 17 [117–130]
DBP (mmHg)	75 ± 11 [74–79]
Heart Rate (bpm)	74 ± 10 [70–78]

The data show the Mean ± SD, and the brackets indicate the 95 % CI. sAA: salivary alpha amylase, SBP: systolic blood pressure, DBP: diastolic blood pressure.

3. Results

3.1. Starting characteristics of the population

Table 1 shows the initial characteristics of the subjects who participated in the study. The mean age was 45 years old, with most of the participants (41 %) being full-time employees (11/27). Of these participants, 37 % (10/27) were women, and the remaining 63 % (17/27) men. Also, the distribution of their professions was: 18.5 % doctors (5/27), 18.5 % nurses (5/27), 18.5 % EMT (5/27), 22 % EMT drivers (6/27), and 22 % resident medical intern (MIR) in their fourth year (R4), part of the Family and Community Medicine specialty (6/27).

3.2. Effect of the emergency event on stress parameters

As shown in Fig. 1, an increase was observed of all the stress markers measured after the intervention of the MEU health professionals after handling any of the five emergency situations defined in the inclusion criteria. The sAA values strongly increased by 294 % ($p < 0.001$), indicating a 3-fold increase of these values after the procedure (Fig. 1a). The SBP values also increased, but in this case, the differences were not statistically significant (Fig. 1b). On the contrary, the DBP values increased in a statistically significant manner ($p < 0.001$) after the procedure (Fig. 1c), just as the HR data ($p < 0.001$) (Fig. 1d).

Fig. 2 shows the variation of the sAA levels as a function of the type of emergency handled. Statistically significant differences were observed between the interventions conducted ($p < 0.001$), with the LS procedure and the critical neonate being the procedures that increased the levels of sAA the most in the study participants. The increase in sAA activity

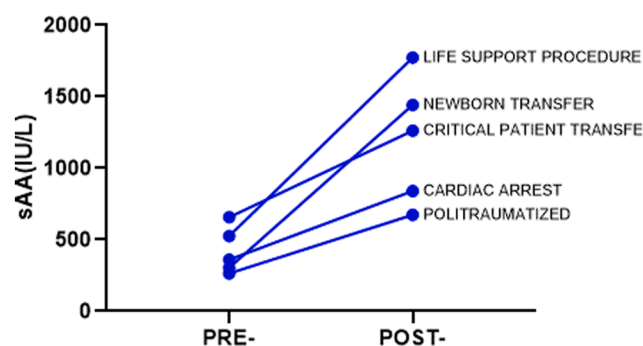


Fig. 2. Variation in the sAA levels after the performance of the MEU in different types of real emergencies. The absolute basal values and their increase are shown.

during the LS procedure was greater and statistically significant than in the severely traumatized patient ($p = 0.016$). When the same analysis was performed considering age, gender, and the previous experience of the participants as covariables, a statistical significance was not found ($p = 0.052$).

With respect to the blood pressure and HR parameters, all the procedures resulted in an increase in their final values with respect to the values prior to the event (Fig. 3). Among these parameters, the cardiac arrest produced a significant increase in SBP ($p = 0.038$, Fig. 3a), DBP ($p < 0.001$, Fig. 3b), and HR ($p < 0.001$, Fig. 3c).

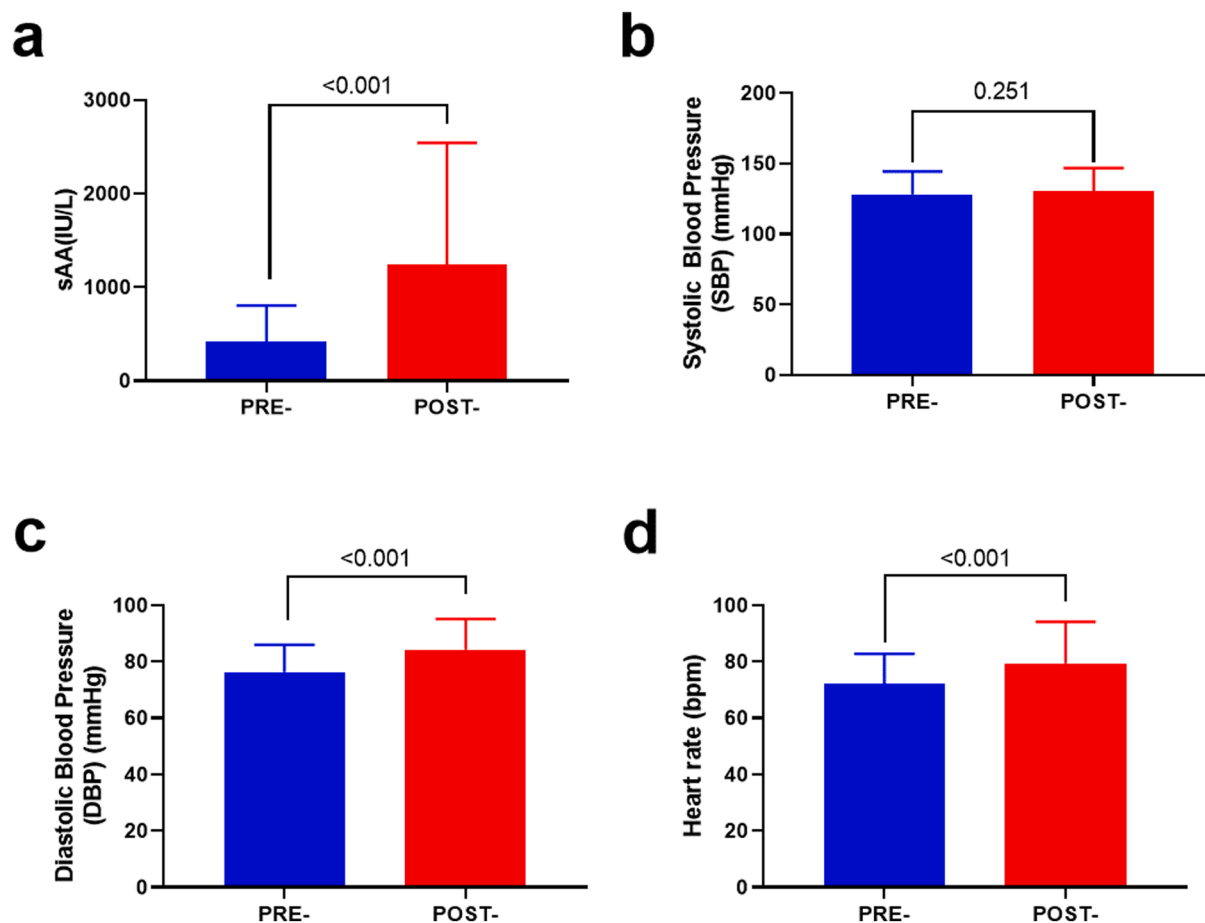


Fig. 1. Increase in the acute stress markers (1a: sAA; 1b: SBP; 1c: DBP; 1d: HR) after the performance of the MEU in real emergencies. The absolute basal values and their increase are shown.

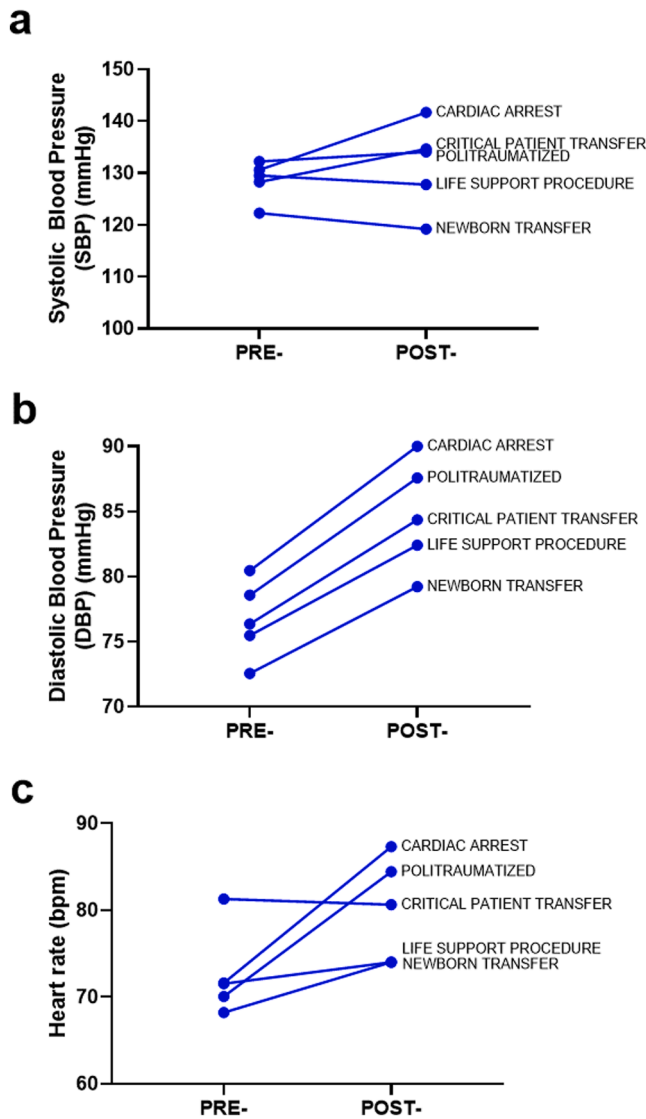


Fig. 3. Variation in the levels of the physiological stress markers (3a: SBP; 3b: DBP; 3c: HR) after the performance of the MEU in real emergencies. The absolute basal values and their increase are shown.

3.3. Effect of the characteristics of the participants on the stress parameters

The influence of variables such as age, sex, and the experience of the participants on the level of statistical significance of the stress parameters was analyzed. With respect to sex, the women obtained base sAA values that were significantly lower than the men (225.6 ± 127.4 and 465.6 ± 409.3 , respectively; $p < 0.001$). However, the values after the event were similar ($p = 0.614$). The initial SBP, DBP, and HR values were also statistically significantly lower in women ($p < 0.050$ for every

case).

Another variable analyzed was the previous experience of the participants in emergency services. The increase in the activity of sAA was significantly greater in the substitutes than in the other groups ($p < 0.001$). With respect to the SBP, differences were also found between groups, but these were not significant ($p = 0.066$) (it was higher in the MIR participants). However, for the DBP, the differences were statistically significant ($p = 0.017$), and it was also higher in the MIR participants. Table 2 shows the changes in the stress parameters as a function of the participant's profession. An increase in the sAA values was observed in all the groups, but without it being significant ($p = 0.511$). The groups with the greatest increases were the EMTs and EMT drivers, especially due to the striking increase in 3 participants within this group (Fig. 4a). Nevertheless, the blood pressure parameters significantly changed according to profession. More specifically, our data indicated that the R4 experienced a statistically significant increase in SBP (Fig. 4b) and DBP (Fig. 4c) as compared to nurses and doctors, while the HR also decreased in this group as compared to the EMT drivers and nurses (Fig. 4d).

4. Discussion

Health professionals, especially those who in emergencies, face unpredictable and complex situations which require the fast making of decisions, and where stress from the lack of adaptation to the situation can result in the inadequate management of the threats against a patient's life [8].

The overall results of the study show a clear increase in the stress markers after the intervention of a MEU in an emergency. Just as the study by Lopez-Jornet et al. and Tecles et al., a salivary biomarker was utilized as the diagnosis tool of stress as opposed to others obtained through a blood analysis, due to its advantages, such as: the ease of sampling, safety, and accessibility, and its non-invasive nature. The extraction of blood was avoided, as it is considered to be a stimulant of stress and a confounding factor in the measurement of stress [11,12].

Of all the stress markers, the sAA values significantly increased, with the basal values multiplied by three after the procedure. These findings indicate that this biomarker is reliable for the measurement of acute stress in saliva, and are in agreement with studies from authors such as Valentin et al., and Guglielminotti et al., who obtained significant increases in the measurement of sAA [13,14]. The difference between the present study and those from these authors is that in our case, the stress stimulants were real emergencies and not high-fidelity clinical simulation scenarios, such as in the case of Valentin et al., or acute stress in patients in the case of Guglielminotti et al. In the case of the former study, salivary cortisol was also measured, but the increase in this biomarker was not significant, showing its decreased usefulness in studies that assess acute stress with the activation of SNS [12].

When this same analysis was performed considering the variations in the sAA as a function of the type of emergency handled, statistically significant differences were observed between the interventions performed, with the LS and critical neonate procedures increasing the levels of sAA to a greater extent in the study participants. In fact, the increase in sAA activity during the LS procedure was statistically and significantly greater than the case of a major trauma patient. When this same

Table 2

Relationship between professional categories and the changes in the stress markers (Post – Pre values).

	Physician (n = 17)	Nursing (n = 17)	T.A. (n = 17)	Driver (n = 17)	R4 (n = 8)	p (ANOVA)
sAA (IU/L)	602(292–912)	719 (198–1241)	863 (498–1228)	1212 (234–2190)	548 (109–988)	0.511
SBP (mmHg)	0.29 (–4.22 to 4.81)	–4.94 (–16.94 to 7.06)	6.35 (–1.88 to 14.58)	1.88 (–6.22 to 9.98)	14.00 (0.81–27.19)	<0.001
DBP (mmHg)	5.65 (2.03–9.27)	0.82 (–4.79 to 6.44)	10.35 (4.58–16.13)	9.53 (3.59–15.47)	19.00 (8.61–29.39)	0.002
HR (bpm)	6.65 (1.79–11.50)	6.00 (2.37–9.63)	2.65 (–3.72 to 9.01)	13.59 (7.27–19.91)	6.38 (–0.79 to 13.54)	0.048

Data represent mean and 95% CI. sAA: salivary amylase activity. SBP: systolic blood pressure. DBP: diastolic blood pressure. HR: heart ratio. Statistical differences among groups were analyzed by a one-way (professional category) ANOVA with a Tukey's post hoc test correction for multiple comparisons. Bold characters represent statistically significant differences.

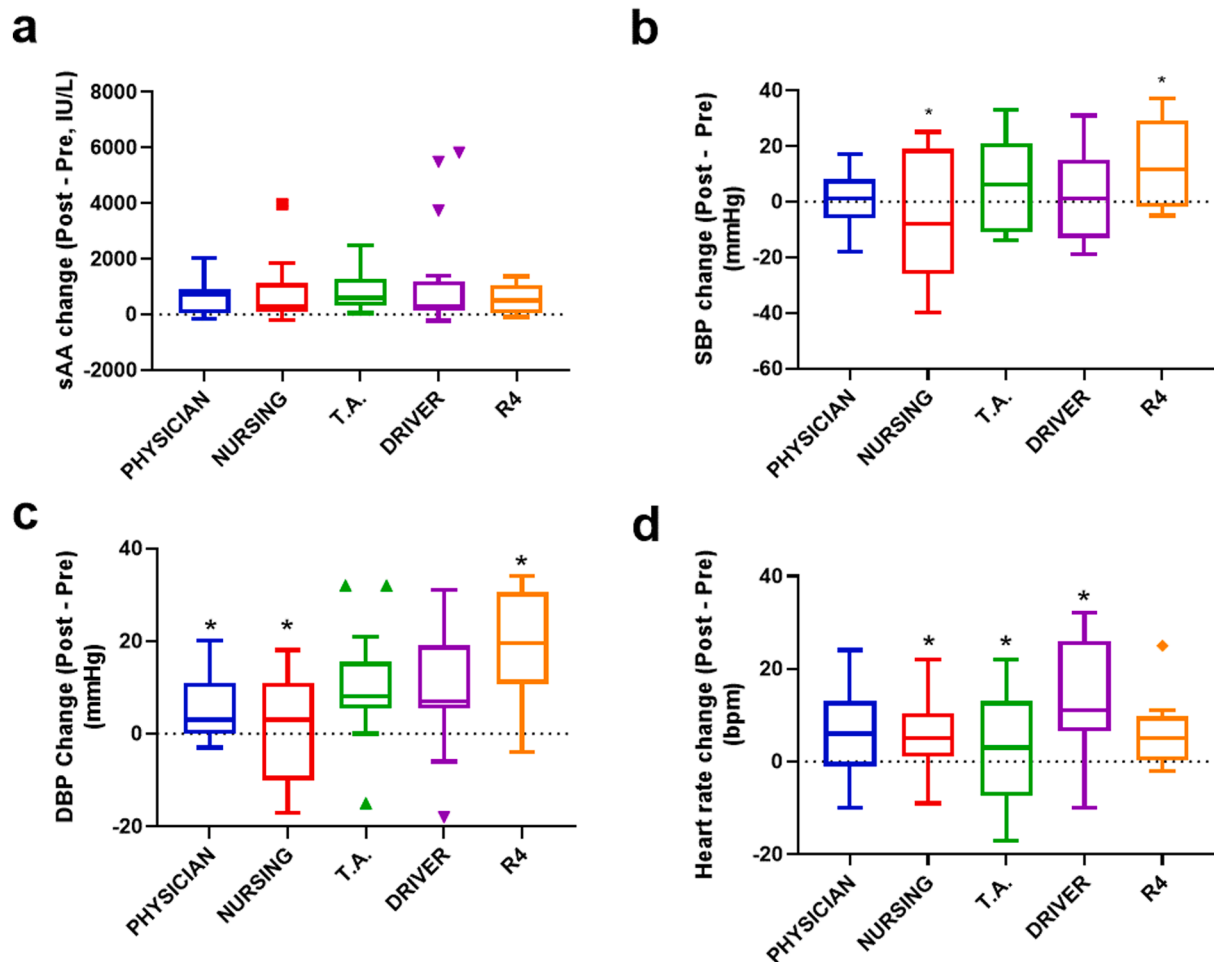


Fig. 4. Relationship between professional categories and the changes in the stress markers 5a: sAA, 5b: SBP, 5c: DBP, 5d: mean HR.

analysis was performed considering age, gender, and the prior experience of the participants as covariables, the level of statistical significance was lost, which indicated that these variables had an influence on the manner in which the participants perceived the stress created during the event. These aspects could not be compared with other authors due to the absence of studies in which the stress of health professionals was measured in real situations.

As for the physiological stress markers, blood pressure, and HR, all the procedures increased their final values with respect to the values prior to the procedure. The cardiac arrest situation increased these parameters the most. This could be due to the fact that cardiorespiratory reanimation implies a high physical effort. As opposed to what was found for sAA, the LS procedure and the critical neonate produced a less representative effect with respect to these variables, although these interventions were also initiated with a lower basal measurement.

Having in mind the influence of variables such as age, sex, and the experience of the participants on the level of statistical significance of the stress parameters, an analysis was performed on how these participant's variables interacted with the stress markers. With respect to sex, the women had prior sAA values that were significantly lower than the men; however, the values after the emergency were similar, which indicate a slightly higher increase in the women. The basal SBP, DBP, and HR values were also statistically significantly lower for the women. The prior experience in emergency services variable of the participants showed a significant increase in the sAA of the substitutes with respect to the other group of health professionals. An increase in the MIR group was not observed despite their lesser experience, perhaps due to the support of the adjunct doctor who had more experience.

Lastly, when comparing the changes in the stress parameters as a function of the profession of the participant, an increase was observed in the sAA values in every group, although in this case, the differences did not reach levels of statistical significance. The groups with the greatest increases were the EMT and the drivers, especially due to the striking increase in 3 participants within this group. These findings could be influenced by some to the tasks performed by these groups of professionals, such as the mobilization and immobilization procedures, as well as the start of external chest compressions during cardiorespiratory resuscitation.

The present research is a great advancement that defines the starting point for the analysis and control of stress that is experienced by health professionals during real emergency events. This method of stress analysis could be easily adapted to all the EMS, as it does not interfere with the caregiving activities, due to the bloodless sampling and the stability of the sample until its analysis. We strongly argue that knowing the real stress experienced by emergency health professionals could provide benefits for the improvement of the training on these types of situations or for achieving thresholds of stress that do not imply health risks for the professionals, and to minimize errors in the management of the threats against the patient's life due to stress. Therefore, we can attest that in this work, a first determination of the stress suffered by these health professionals was performed with a reliable and objective biomarker. These data can be utilized for future clinical simulation studies which seek to reach values that are similar to the real-world ones, or for studies on the improvement of stress in the professional sector.

The main limitation of this study is the sample size. Thus, we cannot

generalize these results, outside of medical units that have a similar structure and composition as ours. Increasing the number of subjects, as well as the duration of the study, would increase its power, improve the internal and external validity, as well as the influence of other variables. Likewise, the level of acute stress experience could be influenced by the different personality patterns of the health professionals.

The determination of the maximum tolerable levels of stress is therefore recommended, so that future research studies could be aimed at measuring these thresholds, having in mind the different personality patterns of the health professional. These results are the first data published in this regard, and could be used as a reference to follow in clinical simulation in the training of students and the training of nursing professionals.

Having demonstrated an increase in stress levels in EMS personnel by measuring physiological and chemical markers, future lines of research are opened to resolve the question of how to reduce stress in an exceptional situation. Clinical simulation and training are postulated as two great tools to achieve this ambitious objective, but new studies should be carried out to corroborate it.

5. Conclusions

In conclusion, the determination of acute stress experienced by a EMS during the handling of real emergencies showed significant increases in the acute stress enzymatic marker sAA, with a greater magnitude than the rest of the physiological markers. Secondly, when analyzing the other variables, the women obtained lower basal values of sAA than the men. However, the values after the stressful event were similar. Significant differences were found in the increase in sAA activity depending on the type of emergency handled, with the LS and the transfer of a critical neonate procedures increasing stress the most. The significance of our findings transcends national borders, offering valuable insights into how high-pressure environments impact medical professionals across different cultures and healthcare systems. By revealing the extent of stress experienced by EMS professionals and its correlations with specific variables, this study highlights the urgent need to address the well-being of these professionals as an international priority, emphasizing the adoption of evidence-based practices and the exchange of knowledge between countries to enhance resilience and effectiveness in emergency care.

CRediT authorship contribution statement

Manuel Pons Claramonte: Writing – review & editing, Writing – original draft, Investigation, Formal analysis, Conceptualization. **Sergio Nieto Caballero:** Writing – original draft, Resources, Methodology, Investigation, Formal analysis, Conceptualization. **Damián Escribano Tortosa:** Writing – review & editing, Investigation, Formal analysis, Conceptualization. **Maria Dolores Contreras-Aguilar:** Writing – original draft, Validation, Methodology, Formal analysis, Data curation. **Jose Joaquin Ceron Madrigal:** Writing – review & editing, Methodology, Investigation, Formal analysis, Conceptualization. **Juan José Hernández Morante:** Writing – original draft, Visualization, Validation, Resources, Methodology, Investigation, Formal analysis,

Conceptualization. **Ana Nicolas Carrillo:** Writing – original draft, Methodology, Investigation, Formal analysis, Data curation. **Manuel Pardo Rios:** Writing – review & editing, Writing – original draft, Investigation, Formal analysis, Conceptualization. **Esther Chicharro-Luna:** Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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