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# Nursing workload of trauma patients in the emergency room: A prospective cohort study

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## 1. Introduction

Trauma is considered a worldwide public health problem due to the significant number of cases and deaths in the population, especially of people in an economically active phase. In addition, trauma is responsible for exorbitant expenses with material and human resources which are implicated from pre-hospital care to the rehabilitation of the traumatized patient [1–2].

Pre-hospital care is the first phase of attendance provided to a traumatized patient and aims to maintain the patient's homeostasis until their referral to a hospital. After this phase, the care provided to traumatized patients takes place in the emergency room at the hospital and involves a systematic, quick and careful assessment to define treatment priorities which are essential for maintaining life [3–4].

Efforts are made during this initial care at the hospital which depend on material and technological resources, in addition to a qualified and appropriately dimensioned team in order to provide quality care and patient safety [4]. Considering the significant number of nursing professionals who work in the emergency unit, knowing trauma aspects and pre-hospital care which influence the nursing workload required by traumatized patients during the initial care becomes essential for nursing staff sizing and ensuring the quality and safety of the care [5].

In fact, a literature review identified the amount of nursing time and physical exertion, the level of nursing competency, the weight of direct patient care, and the care complexity as attributes related to the nursing workload concept [6]. Researchers have shown that nurses have been looking for objective instruments for measuring workload in the emergency department [7–9], and highlight the difficulty of directly quantifying this demand for care at the moment of emergency care [8].

In the context of trauma care, it was possible to identify only one study in the literature which analyzed the nursing workload required by traumatized patients in the emergency room and indicated that the demand for care had a positive correlation with the severity of the patients [10]. Therefore, the evidence is scarce regarding the demand for nursing care required by traumatized patients during initial care in the emergency room and the possible influence of trauma and pre-hospital care aspects on this workload.

Based on the aspects mentioned above and the knowledge gaps in the literature regarding factors which influence the nursing workload required by trauma patients in the emergency room, the following question arises: which aspects of trauma and pre-hospital care influence the nursing workload during the initial care provided to traumatized patients in the emergency room? In order to clarify this question, the present study aimed to identify the nursing workload predictors required by trauma patients in the emergency room.

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## 2. Methods

### 2.1. Design and setting

This is a prospective cohort study using a quantitative approach to trauma patients in the emergency room of a Trauma Centre located in São Paulo, Brazil. The researcher followed the initial care of trauma patients admitted to the institution from December 1, 2016 to November 30, 2017 in a random strategy, and contemplating a daytime period (from 7 am to 6:59 pm) followed by a 36-hour break for 15 days, and an evening period (from 7 pm to 6:59 am) followed by a 36-hour break in the next 15 days, thus ensuring that all days of the week and periods were evaluated.

### 2.2. Participants

The convenience sample was composed of trauma patients aged 18 years or older who had received pre-hospital care and were admitted to the hospital directly from the scene of a traumatic event. Occurrences due to drowning and poisoning were excluded from the series since the pathophysiology of these cases differs from that which occurs in cases of blunt and/or penetrating trauma.

### 2.3. Variables

The dependent variable of the study was the nursing workload required for a traumatized patient in the emergency room measured by the Nursing Activities Score (NAS). The NAS instrument analyzes 23 nursing interventions, each of which has a weight on the final score that expresses the percentage of time spent by the nursing team providing direct and indirect care to the patient, reaching a maximum of 176.8 points. A total score of 100 points indicates that the patient required 100% of the nurse's time for their care [11]. Although the NAS was developed in the context of the adult intensive care unit (ICU), researchers have been applying the instrument in other units of the hospital, including pediatrics and neonatology sectors [12]. In this sense, the NAS was selected to evaluate the nursing workload of the patients by calculating whether the performance or not of each of the 23 nursing interventions described in the instrument during the initial care was provided to each traumatized patient in the emergency room.

The independent variables of the research included age, sex, trauma mechanism, external cause, day of the week and the occurrence period of the trauma, the transport type and pre-hospital support modality, pre-hospital care times (response, scene and transport times) and interventions performed during pre-hospital care: immobilizations (cervical collar, rigid board, head block, and immobilization of limbs and/or pelvis), basic respiratory support (oxygen therapy, oropharyngeal cannula insertion, airway aspiration and/or ventilation with bag-valve-mask) and advanced respiratory support (intubation, insertion of supraglottic device and/or thoracentesis); basic circulatory support (compressive dressing, tourniquet and/or cardiopulmonary resuscitation) and advanced circulatory support (peripheral venous access, intraosseous access and administration of fluids/medications), in addition to temperature control (cover the patient with a warm blanket). Additional independent variables analyzed included physiological severity indexes: Revised Trauma Score triage (RTSt) [13], Revised Trauma Score (RTS) [13], Rapid Emergency Medicine Score (REMS) [14], and the modified Rapid Emergency Medicine Score (mREMS) [15].

The RTSt index is applied in the pre-hospital environment and uses the parameters of respiratory rate (RR), systolic blood pressure (SBP) and the Glasgow Coma Scale (GCS) score of the traumatized patient for its calculation, with the final score varying from 0 to 12 (the lower the value, the more severe the patient) [12]. The RTS is calculated at the hospital admission of the traumatized patient and uses the same parameters as the RTSt; however, different weights are applied for each of them and the score can vary from zero to 7.8408 (the lower the value, the more severe the patient) [13].

REMS is an index based on the Acute Physiology and Chronic Health Evaluation version II (APACHE II) and is applicable to all emergency patients, regardless of pathology. In addition to age, the following physiological variables are considered for its calculation: RR, heart rate (HR), GCS score, peripheral oxygen saturation ($SpO_2$) and mean arterial pressure (MAP). The variables are scored from zero to 6 depending on the value obtained, and the index can reach a maximum value of 26 points (the higher the REMS value, the worse the patient's prognosis) [14]. The mREMS index is based on REMS, and was created to more accurately represent the trauma population. For this there were changes in the age weighting and the GCS, in addition to replacing MAP by SBP. The mREMS value can reach a maximum value of 26 points and (like REMS) the higher the score, the more severe the patient [15].

### 2.4. Data sources

Data were collected by the main researcher of this study, who is a member of the international NAS network composed of nurses and researchers from different countries, and trained in accordance with the applicability of the NAS tool. All data were obtained by monitoring the information exchange between the pre-hospital and intra-hospital teams at the time of the patient's arrival at the institution, in addition to only direct observation of the care provided by the nursing team to the traumatized person in the emergency room to identify the performed nursing interventions and the NAS measurement. Thus, the main researcher applied the original NAS instrument [11] guided by the instruction manual for implementing NAS [16]. Moreover, doubts regarding the data collection of the NAS were clarified among the researchers of this study, also members of the international NAS network. The vital signs data and GCS score measured at the time of the patient's admission to the emergency room were considered for calculating the severity indices (RTSt, RTS, REMS and mREMS).

The study was approved by the Research Ethics Committee of the institution (protocol number 1,815,941) and met all the required ethical terms, including signing the informed consent form by the participants or legal guardians.

### 2.5. Data analysis

The comparative analysis of the nursing workload according to the independent variables of the study was performed using the Mann-Whitney, Kruskall-Wallis and Brunner-Munzel tests, in addition to the Pearson correlation coefficient. Multiple linear regression was used through a model to identify the nursing workload predictors required by traumatized patients while in the emergency room, with the Least Absolute Shrinkage and Selection Operator (LASSO) selection method being applied for selecting the variables. The predictive capacity of this model was verified by the determination coefficient ($r^2$). The Variance Inflation Factor (VIF) was applied to identify the presence of multicollinearity among the variables that remained in the model, with a VIF value below 10 being interpreted as the absence of collinearity. The significance level adopted in all analyzes was 5%.

## 3. Results

The study sample consisted of 400 trauma patients admitted to the emergency room, mostly men (77.2%) with a mean age of 40.5 (SD = 17.3) years. A blunt trauma mechanism (92.2%) was the most frequent and traffic accidents (59.3%) were the main external cause, with emphasis on trauma involving motorcyclists (30.5%).

The mean scores for the RTSt, RTS, REMS and mREMS severity indexes were 10.5 (SD = 2.8), 6.3 (SD = 2.2), 4.9 (SD = 5.2) and 4.9 (SD = 5.7), respectively. The highest frequency of traumatic events occurred on Thursdays (21.3%) and during the day (58.3%). Pre-hospital ground transportation (73.5%) and basic support modality (57.5%) prevailed

with mean response, scene and transportation times of 16.1 (SD = 9.4), 16.1 (SD = 12.8) and 12.8 (SD = 8.4) minutes, respectively.

The interventions most frequently performed during pre-hospital care were immobilizations with a rigid board (98.8%), cervical collar (91.8%) and/or head block (88.5%). A total of 385 interventions for basic and advanced respiratory support were performed on traumatized patients, with emphasis on oxygen therapy (37.7%), ventilation with bag-valve-mask (25.0%) and intubation (23.7%). Regarding basic and advanced circulatory support, a higher frequency of compressive dressings (75.5%), peripheral venous access (39.0%) and medication administration (37.0%) were identified. A warm blanket was applied to 174 (43.5%) patients during the pre-hospital care to prevent hypothermia.

Regarding the nursing workload required by patients in the emergency room, a mean NAS score of 71.0 (SD = 25.0) was identified with a range from 36.4 to 149.8. The main nursing interventions performed on patients during initial care were monitoring and controls (100.0%), administrative and managerial tasks (100.0%), hygiene procedures (99.3%), mobilization and positioning (96.3%), medication, except vasoactive drugs (96.2%), laboratory investigations (85.2%), support and care for family members and patients (75.0%), in addition to specific interventions within (78.8%) and outside (79.0%) the emergency room.

In the comparative analysis of the nursing workload according to the independent variables of the study, it was possible to identify that men (mean NAS 72.3) demanded significantly ($p = 0.029$) greater nursing workload than women (mean NAS 66.5). The correlation between age of trauma patients and NAS was weak ($r = 0.017$) and non-significant ($p = 0.733$).

The external cause had a statistically significant association ($p < 0.001$) with NAS and the highest score value was identified in cases of intentional self-harm (mean NAS 95.4), i.e. suicide attempts. Traumatized patients referred by pre-hospital air transport (mean NAS 85.5) and assisted by advanced support teams (mean NAS 83.2) significantly demanded ($p < 0.001$) a higher nursing workload in the emergency room than those transported by land (mean NAS 65.8) and attended by basic teams (mean NAS 61.9) (Table 1). There was no significant difference between the NAS values and the day of the week ($p = 0.437$) or the trauma occurrence period ($p = 0.533$) variables. In addition, weak (r values $< 0.205$) and non-significant ($p > 0.050$) correlations were observed between the pre-hospital times (response, scene and transport) and the NAS score.

Table 2 shows a statistically significant ($p < 0.001$) and moderate correlation (r values $> 0.450$) between the physiological severity indices (RTSt, RTS, REMS and mREMS) and the NAS measured during the initial care. In addition, significant differences ($p \leq 0.050$) were identified between the nursing workload required by trauma patients in the emergency room and the following procedures performed during pre-hospital care: immobilization of the lower limbs and pelvis, oxygen therapy, airway aspiration, ventilation with bag-valve-mask, compressive dressing, cardiopulmonary resuscitation, temperature control, in addition to all procedures related to advanced respiratory and circulatory support. With the exception of lower limb immobilization, all patients who received any of the interventions previously mentioned in the pre-hospital phase demanded a greater nursing workload (higher NAS averages) compared to those who did not undergo any of these procedures.

According to data in Table 3, the final model of predictive factors of NAS included the external cause of intentional self-harm ($p < 0.001$), intubation ($p = 0.003$), compressive dressing ($p = 0.001$) and use of a warm blanket ($p = 0.008$) performed during the pre-hospital care, in addition to the mREMS ($p < 0.001$) calculated at the patient's admission to the emergency room, revealing that these variables increase the nursing workload during the initial care of trauma patients in the emergency room. The VIF values (<2.14) indicated the absence of collinearity between the variables that remained in the model (Table 3)

**Table 1**
Values of the Nursing Activities Score according to the trauma mechanism, external cause, transport type and pre-hospital support modality. São Paulo-Brazil, Dec/2016-Nov/2017.

| Variables | Mean (SD) | Median | Min-Max | 95%CI | p-value |
|---|---|---|---|---|---|
| **Trauma mechanism** | | | | | |
| Blunt | 70.6 (25.0) | 65.4 | 36.4–149.8 | 66.5–72.0 | 0.206* |
| Penetrating | 75.5 (22.1) | 80.5 | 43.4–127.4 | 66.5–85.2 | |
| **External cause** | | | | | |
| Traffic events | 68.9 (24.8) | 61.1 | 38.1–147.0 | 63.4–71.0 | **<0.001**** |
| Falls | 66.2 (22.1) | 59.2 | 41.3–124.7 | 58.4–70.8 | |
| Aggressions | 75.3 (20.6) | 80.1 | 43.4–127.4 | 67.9–83.7 | |
| Intentional self-harms | 95.4 (24.9) | 93.7 | 50.9–149.8 | 82.5–106.6 | |
| Exposure to mechanical forces | 80.6 (28.1) | 84.1 | 41.3–125 | 63.6–97.0 | |
| Others | 81.4 (28.2) | 83.3 | 36.4–123.7 | 64.1–100.0 | |
| **Type of pre-hospital transport** | | | | | |
| Land | 65.8 (23.2) | 57.0 | 36.4–149.8 | 60.9–67.6 | **<0.001*** |
| Air | 85.5 (23.5) | 83.0 | 43.7–68.7 | 79.9–89.2 | |
| **Pre-hospital support modality** | | | | | |
| Basic | 61.9 (21.6) | 50.9 | 36.4–124.7 | 54.6–63.4 | **<0.001***** |
| Advanced | 83.2 (23.7) | 82.1 | 41.3–149.8 | 78.7–85.8 | |

Legend: SD = standard deviation; Min = minimum; Max = maximum; CI = confidence interval *Mann-Whitney test; **Kruskal-Wallis test; ***Brunner-Munzel test

**Table 2**
Correlation between the values of the Nursing Activities Score and the physiological severity indices. São Paulo-Brazil, Dec/2016-Nov/2017.

| Physiological severity indices | r* | p-value |
|---|---|---|
| RTSt | − 0.454 | <0.001 |
| RTS | − 0.579 | <0.001 |
| REMS | 0.495 | <0.001 |
| mREMS | 0.579 | <0.001 |

Legend: RTSt = Revised Trauma Score triage; RTS = Revised Trauma Score; REMS = Rapid Emergency Medicine Score; mREMS = modified Rapid Emergency Medicine Score; *Pearson's Correlation Coefficient.

**Table 3**
Predictive model of the nursing workload required by trauma patients in the emergency room. São Paulo-Brazil, Dec/2016-Nov/2017.

| Variables | Coefficient | 95%CI | p-value | VIF |
|---|---|---|---|---|
| Intentional self-harm | 16.27 | 7.59–24.95 | <0.001 | 1.03 |
| Intubation (pre-hospital phase) | 9.24 | 3.16–15.31 | 0.003 | 2.13 |
| Compressive dressing (pre-hospital phase) | 7.15 | 2.85–11.45 | 0.001 | 1.09 |
| Use of warm blanket (pre-hospital phase) | 6.54 | 1.72–11.35 | 0.008 | 1.82 |
| mREMS score | 1.76 | 1.39–2.12 | <0.001 | 1.37 |

Legend: CI = confidence interval; VIF = Variance Inflation Factor; mREMS = modified Rapid Emergency Medicine Score.

and the predictive capacity of the proposed model was satisfactory ($r^2 = 0.483$).

## 4. Discussion

Knowing the characteristics of the traumatized patient and the trauma and pre-hospital care aspects which influence the nursing workload required during the initial care is essential for developing strategies aimed at improving the quality of care provided, including the sizing of the nursing team. It is known that nurses who work in an emergency unit experience the reality of a high workload due to the high demand from patients [8]. In this context, it is noteworthy that great efforts are required from the nursing team during hospital care to ensure the best care for traumatized patients and the NAS has been considered a reliable and favorable performance instrument for measuring the workload required for treating these patients [17]. For example, a Chinese study identified a mean NAS score ranging from 54.14 to 110.40 for trauma patients in the emergency department [10], which is less than what we found.

In this study, men demanded greater nursing workload than women. The analysis of the factors associated with the high nursing workload (NAS > 75) of traumatized patients at the ICU identified that the chance of men presenting a high workload was about three times higher compared to women in the sample [18]. The impact of sex on the consequences of trauma has been discussed in different studies with animals, revealing that hormonal characteristics protect women from the occurrence of severe bleeding [19–20], a situation which would require immediate interventions such as monitoring and control, volume replacement, strict urinary output control and specific interventions for the diagnosis of hemorrhagic injuries, which would certainly result in high NAS values.

It was also observed that patients who attempted suicide obtained the highest mean NAS values and may be associated with the performance of a set of nursing interventions contemplated in the instrument for hemodynamic and respiratory support of these critically ill patients during the initial care in the emergency room. In addition, support for the family and the patient itself stands out, often with a high stress and anxiety level in facing the delicate situational context associated with the suicide attempt. Furthermore, 7 of the 18 patients who were admitted to the hospital due to intentional self-harm had cardiac arrest in the emergency room and underwent cardiopulmonary resuscitation procedures, which considerably increased the NAS score.

In sequence, it is noteworthy that advanced pre-hospital care substantially increases the number of interventions performed by nurses and doctors at the scene of the traumatic event [21], and this fact is directly related to the clinical instability of the patients. This explains the higher NAS values among patients who were transported by helicopter and/or received advanced pre-hospital support in this study, both with the mandatory presence of the doctor and nurse, since attending trauma patients in the emergency room implies continuity of care provided in the pre-hospital setting. It is known that the greater the number of procedures performed in the pre-hospital context in these circumstances, the greater the number of nursing interventions aimed at monitoring and maintaining these devices for hemodynamic patient stabilization.

Additionally, the interventions performed in the pre-hospital phase related to basic and advanced respiratory support are recommended in the ABCDE of trauma care, with emphasis on the letters “A (airway patency ensured)” and “B (effective breathing and ventilation)”, and show the possible presence of serious injuries such as airway obstruction and/or chest injuries, with an imminent risk of death of the patient [3–4]. The continuity of care necessary for these patients in the emergency room [3–4,22] requires the nursing team to at least perform basic activities contemplated in the NAS aimed at monitoring and controls, mobilization and positioning, as well as ventilatory support. The sum of the time spent by the nursing professional in carrying out these activities can reach 44.2 points, which means approximately 10 h of work by the nursing professional (each point of the NAS is equivalent to 14.4 min) [11] in providing care to these patients.

Still on this line of reasoning, immobilizing the pelvis and basic circulatory support interventions (compressive dressing and cardiopulmonary resuscitation) and advanced circulatory support interventions (peripheral venous access, intraosseous access, volume infusion and medication administration) performed in the pre-hospital care reflect the need for hemorrhage control and clinical stabilization of the traumatized patient due to possible hemorrhagic shock, which are actions related to the letter “C (circulation with hemorrhage control)” which composes the ABCDE of trauma care [3–4,22]. Moreover, the use of a warm blanket in the pre-hospital context is essential to avoid the lethal trauma triad characterized by the combination of coagulopathy, acidosis and hypothermia which are associated with high mortality rates of traumatized patients [3–4]. The nursing team must frequently monitor the patient’s temperature during initial care and ensure they warm-up with an infusion of a heated solution and the use of a warm blanket. These procedures performed during the pre-hospital phase described above increase the nursing workload required by trauma patients during initial care in the emergency room, as evidenced in this study.

In relation to the severity indexes, it is observed in the literature that severe trauma patients require a high nursing workload in both the emergency observation room [10] and in the ICU [18]. However, no investigations were identified which analyzed the correlation of NAS with the physiological severity indices applied in this study which would allow greater comparisons.

It is noteworthy that the variables which composed the NAS predictive model in this study (already explored earlier in this section) reflect the patient’s severity and the need for immediate interventions aimed at ensuring oxygenation, controlling bleeding and preventing hypothermia. The demand for nursing workload required by traumatized patients in the emergency room under these conditions is high, since the nursing interventions performed during the initial care of these patients provide an increased final sum of points when scored on the NAS instrument.

Finally, the results of this study regarding pre-hospital care characteristics that influenced and increased the workload required by trauma patients in the emergency room based on the amount of time dedicated to performing nursing activities during initial care can assist nursing managers to correctly size the emergency department’s trauma nursing team and elaborate strategies for training professionals to provide care with quality and efficiency, ensuring safety and increased survival of severe trauma victims. Therefore, we recommend the daily application of the NAS in the emergency room to identify the real nursing workload required by these trauma patients. It is noteworthy that the study was carried out in a single institution as a limitation of this study, which may lead to possible restrictions in the external validation of results.

## 5. Conclusion

The nursing workload predictors required by traumatized patients in the emergency room were intentional self-harm, severity and intubation, compressive dressings and use of a warm blanket to prevent hypothermia prevent performed during the pre-hospital care. Therefore, knowing these predictors makes it possible to predict the appropriate sizing of the nursing team in the emergency room and capacitate them to ensure that safe care is provided to trauma patients.

## CRediT authorship contribution statement

**Ane Karoline Silva Bonfim:** conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, validation, visualization, writing - original draft, writing - review & editing. **Isadora Castilho Moreira de Oliveira Passos:** formal analysis, investigation, validation,

visualization, writing - original draft. **Carmen Mohamad Rida Saleh:** investigation, validation, visualization, writing - original draft, writing - review & editing. **Katia Grillo Padilha:** conceptualization, investigation, validation, visualization, writing - original draft, writing - review & editing. **Lilia de Souza Nogueira:** conceptualization, formal analysis, funding acquisition, investigation, methodology, supervision, validation, visualization, writing - original draft, writing - review & editing.

## Ethical Statement

The research was approved by the Research Ethics Committee of the institution (protocol number 1,815,941) and met all the required ethical terms, including signing the informed consent form by the participants or legal guardians.

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## 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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