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Association between vital signs and Manchester Triage System: a retrospective observational study

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ABSTRACT

Aim: to evaluate the association between vital signs collected at the patient's entrance to the emergency department and the risk levels of the Manchester Triage System (MTS). **Method:** this is a retrospective observational study; whose sample was 154,714 patients. The exposure factor was the vital signs data, and the primary endpoint was the level of risk of MTS. Statistical, descriptive and inferential analyzes were conducted. **Results:** the most evaluated vital data was pain intensity; blood pressure was the least evaluated. Changes in heart rate to more or less of physiological patterns have increased the clinical priority of patients. **Discussion:** the higher the level of severity of MTS, the greater the variability of the mean of the vital signs evaluated. **Conclusion:** more severe patients tend to present greater variation in terms of vital signs on admission to the emergency department.

Descriptors: Nursing; Triage; Vital Signs; Clinical Evolution.

INTRODUCTION

The measurement of vital signs is inherent to nursing practice and is one of the indicators of evaluation of the general state of the patient. The frequency of measurement varies according to the doctor's and the nurse's prescription and the complaint presented by the patient[1].

The measurement of vital signs is often used as a tool for decision-making in terms of clinical behavior on the patient's care plan. Experts have acknowledged the importance of vital signs observation, and warn that measuring them can help detect serious illnesses during screening in emergency departments[2]. These services are usually organized by a risk classification system, which establishes the priority of care based on the complaint presented by the patient[3].

Among the different triage systems used to guide the nurse's assessment in the risk classification, the Manchester Triage System (MTS) stands out. This system stratifies five levels of priority and is composed of algorithms applied from an initial complaint, structured in flowcharts with questions or measurements, associated with a waiting time and symbolized by a color[4]. This protocol is currently used in Portugal and other countries such as Brazil, England, Germany, Austria, Norway and Spain.

Although the vital signs measurement is common practice in emergency departments, it is not mandatory to measure the vital signs in all the flowcharts in the evaluation of the patients using MTS. Nevertheless, a study carried out showed that, in children, those with abnormal vital signs were classified at higher levels of MTS priority[5]. The existing literature points to the possibility of predicting the patient's level of risk using MTS, based on the vital data presented on arrival at the emergency department. However, other studies are necessary to validate these findings in adults.

There is a paucity of research that indicates the best frequency with which vital signs should be monitored in emergency departments[1]. Few studies evaluate the relationship between vital signs presented by the patient upon arrival at the emergency department, the risk levels established by the MTS, and the outcomes of need for hospitalization, discharge/transfer and death.

Thus, this study was designed with the main objective of analyzing the association between the vital signs collected at the patient's entrance into the emergency department and the risk levels established by the MTS, and to evaluate the association between the vital signs collected at the patient's entrance in the service and the outcomes: need for hospitalization, discharge/transfer and death.

METHOD

This is a retrospective observational study, performed at the emergency department of the *Centro Hospitalar Universitário de Coimbra* (CHUC - University Hospital Center of Coimbra), Portugal. The CHUC is formed by a network of hospital units, services and technologies, structured and integrated, constituting the main gateway of the municipality of Coimbra (and other satellites in this city) for urgent care, besides being a reference for other emergency services units in the central region of the country.

The study population consisted of 154,714 patients, corresponding to all patients seen at the emergency room at the study site between January 1 and December

31, 2012, screened by a nurse using MTS. The sample size corresponded to the total population.

The data collection was carried out between September and December 2013 through the consultation of the ALERT® software database, which is a management system for the risk classification of patients seeking the emergency service, having as a guiding protocol the MTS. The vital signs data collected during the risk classification were considered as exposure factors and the risk level of the patient was considered as the primary outcome after the risk classification, using MTS. It should be noted that vital signs were collected within 20 minutes after the patient's arrival at the emergency department. The secondary outcomes Hospital discharge/transfer, length of hospital stay, and death were also assessed.

Data were processed and analyzed using Statistical Package for Social Sciences (SPSS), version 17.0. To characterize the patients' profile, descriptive statistics were used by means of frequency distribution tables. To verify the existence of a relationship between the vital signs presented by the patient at the time of the classification of risk and the primary and secondary outcomes of the study, inferential statistical analysis was used.

In order to verify the existence of a difference between the vital signs collected in the groups of patients classified in the different levels of MTS severity and between the groups of patients who needed or not hospitalization and those who were discharged or who died, the Levene test for homogeneity of variances, and the Kruskall-Wallis test were used to verify whether the vital data values differed between the different levels of MTS risk. Results were considered significant with $p<0.05$.

The study was authorized by the hospital administration after a favorable opinion from the Ethics Committee of the Health Sciences Research Unit: Nursing (Opinion no. 120-11/2012). Data were collected anonymously, and the privacy rights of the study subjects were guaranteed.

RESULTS

The majority (56.43%) of the patients were female. Age ranged from 0 to 112 years (mean: 53.65 + 21.18 dp), with those aged 71 or over (41.38%) prevailing. It was verified that the greater the age, the greater the demand for care. Regarding the "hospitalization" outcome, of the total number of patients attended, only 23,664 (15.30%) were hospitalized. Of these, the mean length of hospital stay was 9.89 days (0-276 days). There was a very weak but statistically significant correlation between age and length of hospital stay ($R2 = 0.018$, $p <0.0001$). At each 0.07 years of age, the length of hospital stays increased by 4.86 days. The majority (91.73%) of hospitalized patients were discharged or transferred to another service; and 8.27% evolved to death.

Regarding clinical priority, 54.21% of the patients were screened as yellow, 29.16% as green, 9.85% as orange, 6.54% as blue and 0.25% as red. Table 1 features the main complaints presented by the patients at the time of screening, following the nomenclature of MTS flowcharts.

Table 1. Main complaints presented by patients at the time of triage. Coimbra, Portugal, 2012

Complaint	(n)	%
Adult indisposition	22.679	14,66
Member problems	18.810	12,16
Ophthalmologic problems	12.150	7,85
Obstetrics / Gynecology	11.253	7,27
Dyspnea	9.234	5,97
Abdominal pain	8.830	5,71
Chest pain	6.780	4,38
Low back pain	6.504	4,2
Others	58.474	37,79
Total	154.714	100,00

Source: research data

It should be noted that the other complaints presented by 58,474 (37.79%) patients were: "mental illness", "urinary problems", "fall", "wounds", "rash", "headache", "ear problems", "local infections and abscesses", "sore throat", "stomatological problems", "vomiting", "gastrointestinal bleeding" and "traumatic brain injury (TBI)", among others".

The most frequently assessed vital sign was pain intensity, while the least evaluated was blood pressure, according to Table 2.

Table 2. Descriptive statistics of the vital signs measurements of the patients who attended the emergency room of the study scenario. Coimbra, Portugal, 2012

Vital sign	Number of measurements	
	n	%
Pain	119.625	77,32
Temperature (°C)	54.404	35,16
Heart Rate (bpm)	49.227	31,82
Glycemia (mg/dl)	11.208	7,24
Respiratory frequency	1.357	0,87
Blood pressure (systolic/ diastolic)	1.230	0,79

Source: research data

Table 3 shows the mean values and standard deviation of each vital signal evaluated in the different risk levels of MTS, as well as the results of the statistical tests used to evaluate the existence of difference between the groups.

Statistical tests indicate that the difference in the variability of body temperature measurements between groups is significant and in the higher priority levels they are bigger, with "hypothermia" and "very hot adult" being identified only at levels 1 and 2 of the property, indicating that temperatures below or far above the range considered as normal indicate urgency of care. Likewise, there was a difference in body temperature between the group of hospitalized and non-hospitalized patients ($p<0.0000$). Of the patients who had their body temperature was measured (Table 2), 12.75% were hospitalized. Of these, the majority (75.83%) was normothermic, 14.20% presented low grade fever/subfebrile on arrival at the emergency department, 8.10% were "hot", 1.04% with hypothermia, and 0.84% with hyperthermia. Still on the patients who had body temperature measured, 92.04% were discharged or transferred and 7.96% died. A significant difference was found between the temperature in these two groups ($p<0.0000$), and of the patients who died, the highest proportion was those with hypothermia on arrival at the emergency department.

Regarding the respiratory rate (RR), there was also a significant difference between the groups, and the higher the severity level, the greater the means and the variability of the RR values. Of the patients who had this vital signal recorded, 80% were classified in levels 1 and 2 of priority, and none were classified in level 5. There was also a significant difference between the patients who were hospitalized and those who were not hospitalized, and those who were discharged or transferred and those who died ($p<0.0000$). Among patients whose RR was measured on arrival

Table 3. Mean and standard deviation of each vital signal evaluated in patients classified in the different risk levels of the Manchester Triage System and association between the classification groups of colors. Coimbra, Portugal, 2012

Vital Sign		Risk level					Statistical tests	
		Red	Orange	Yellow	Green	Blue	Levene test	Kruskall Wallis
T1 (ºC)	Mean	36,42	36,85	36,63	36,53	36,27	F = 497,6 (p<0,0000)	H = 406,7 (p<0,0000)
	DP	1,30	1,21	0,78	0,57	0,42		
RR2 (ripm)	Mean	25,70	24,58	22,93	21,32	—	F = 4,1 (p=0,0064)	H = 17,42 (p = 0,001)
	DP	9,60	9,39	8,58	8,07	—		
HR3 (bpm)	Mean	160,74	93,17	86,24	84,45	89,38	F = 1677,4 (p<0,0000)	H = 508,6 (p<0,0000)
	DP	132,61	42,53	19,74	17,22	17,74		
GC4 (mg/dl)	Mean	252,08	193,89	149,39	151,31	121,85	F = 39,5 (p<0,0000)	H = 307,64 (p<0,0000)
	DP	266,25	168,40	102,87	85,23	43,78		
SBP5 (mmHg)	Mean	152,48	125,88	125,15	121,69	118,43	F = 35,8 (p<0,0000)	H = 47,8 (p<0,0000)
	DP	54,35	28,87	20,52	17,64	10,86		

Note: 1temperature; 2respiratory frequency (respiratory incursions per minute); 3heart rate (beats per minute); 4capillary glycemia (milligrams/deciliter); 5systolic blood pressure (millimeters of mercury).
Source: research data

at the emergency department, 64.39% were hospitalized. Of these, 60.11% were tachypneic, 38.4% and had respiratory rate within physiological patterns, and 1.49% bradypneic. Among those hospitalized, 22.2% died, and the proportion of patients with tachypnea was higher.

Changes in patients' heart rate (HR) to more or less than physiological standards have led to an increase in their clinical priority. Patients classified in levels 1 and 2 of priority presented higher averages and variations in HR value; the bradycardic patients were mostly classified as orange and the tachycardia were classified as priority 1 and 2. There was a difference in heart rate between the group of patients who were hospitalized and those who were not, among those who were discharged or transferred, and among those who died (p<0.0000). Of the total, 26.02% of the patients who had the HR measured were hospitalized. Of these, 63.43% had HR within the physiological patterns, 30.05% were tachycardic and 6.52% bradycardic. Among the patients who had the HR measured on arrival at the emergency department and hospitalized, 9.04% died, with the highest proportion of deaths among those with tachycardia at admission to the sector.

The higher the level of severity, the higher the mean value of capillary glycemia and the greater the variations in the values measured. All patients with hypoglycemia were classified at priority level 1, while those with hyperglycemia were mostly classified at priority levels 1 and 2. There was a difference between the mean blood glucose levels of patients who were hospitalized and those who were not hospitalized, among those who were discharged or transferred, and among those who died (p<0.0000). Of the patients who had capillary glycemia measured, 26.02% were hospitalized. Of these, 66.24% presented normal glycemia, followed by those with hyperglycemia (18.52%), hyperglycemia with ketosis (14.79%) and hypoglycemia (0.45). Among those hospitalized, 13.62% died, and the proportion of patients with hypoglycemia was bigger.

The higher the severity level, the higher the mean values of systolic blood pressure (SBP) and the greater the variations around the mean of this vital signal. It should be noted that normotensive patients were mostly classified at the lowest levels of priority, while patients with hypotension, borderline hypertension, moderate hypertension, and severe hypertension were predominantly classified as red. A significant difference was found between the SBP of patients who were hospitalized and those who were not hospitalized, and those who were discharged or transferred and those who died (p<0.0000). Of the patients who had their blood pressure measured, 33.17% were hospitalized. Of these, 78.4% were normotensive, 7.6% were hypotensive, 7.1% presented borderline hypertension, 4.9% had severe hypertension, and 1.96 had moderate hypertension. Among the patients who were hospitalized, 8.1% died, and the proportion of patients with severe hypertension was bigger.

DISCUSSION

It was evidenced in this study the predominance of female subjects (56.4%), mean age of 53.6 years and a very weak statistical relationship between age and length of stay (R^2=0,018; p<0,0001). These findings corroborate a study carried out in a Lisbon emergency unit, which found 56.1% of women, with a mean age of 52.3 years and a greater proportion of patients hospitalized in the groups whose ages were higher (p<0,001)[6].

Among the hospitalized patients, the mean residence time was of 9.89 days. Although there was no analysis between the MTS risk levels and the length of hospital stay in this study, a Brazilian study found an average residence time of 7.3 days. It also showed that the greater the clinical priority of the patient, the longer the hospital stay (p=0.030), indicating that the higher the level of priority, the greater the patient's severity[7]. A similar study, also carried out in Brazil, showed that patients evolved with different levels of severity among the color groups of the classification, and the higher the priority level, the greater the severity of the patient (p<0.001)[8]. These findings corroborate with the results of a study carried out in Lisbon, which found a clear association between the high priority groups of MTS (red and orange) and the need for hospitalization, and the patients classified in the high priority group were 4.86 times more likely to be hospitalized than those classified in the low priority group (p<0.001)[6].

Regarding the clinical outcomes discharge/transfer and death, among hospitalized patients in this study, 91.7% were discharged and 8.2% died. The association between the risk level and the outcome discharge or death was not investigated. Nevertheless, a Brazilian study found a discharge rate/hospital discharge of 87.7% and 12.3% of death, and the proportion of patients who died was higher in patients classified as red (42.8%) and orange (17, 0%)[7]. In the other priority levels, the proportion of patients who died was 8.9% among those classified as yellow and 9.6% among those classified as green. A similar result was found in a Portuguese study, which indicated a mortality rate among patients classified as red and orange of 4.0%, representing 51.8% of the total number of deaths, while 38.8% of the deaths were patients classified as yellow, green and blue[6].

Regarding clinical priority, 54.21% of patients were screened as yellow, 29.16% as green, 9.85% as orange, 6.54% as blue and

0.25% as red. That is, most patients (89.91%) were screened in the lowest priority group, as evidenced by a Portuguese study, whose percentage of patients classified in the lowest priority groups was 81.1%[6]. It can be noticed that the Emergency Department of the places studied in Portugal attends to patients with emergencies as well as non-urgent cases. This reality is also found in Brazil, which points to the need to raise public awareness about what is an emergency situation, as well as indicates the importance of structuring the care network at different levels of complexity[9].

The "adult malaise" flowchart was the most used to screen the patients in this study (Table 1), confirming the affirmation of other studies that this is one of the most widely used flow charts to screen emergency patients[10-12]. This is a non-specific flowchart, which should be used for patients who do not feel well, but without specific complaint[10]. Therefore, it is questioned if the patient did present himself with nonspecific complaints, if the use of this flowchart reflects a difficulty of the nurse in identifying the main complaint of the patient during data collection or, if the professionals use this flow chart for convenience, since it has wide applicability. It is recommended that new studies are carried out to elucidate these questions.

There are few studies that investigated the relationship between vital signs assessed on arrival at the emergency and the levels of risk established by MTS. Among them, a study with children showed that changes in vital signs at the time of risk classification led to their classification at the highest levels of MTS priority[5]. It should be noted that no publications of the last five years have been found that have evaluated the association between alteration of vital signs and MTS priority levels in adults.

In this study, there was a statistical association between mean values and mean variability for all vital signs evaluated in patients classified in the different priority levels of the Manchester protocol. In general, the higher the level of priority, the higher the values of these vital signs in patients classified as red and orange, and the greater the variability of the mean (Table 3). Thus, although a causal relationship cannot be established, the findings of this study indicate that variations in vital signs are related to the levels of risk established in the MTS.

There was a statistical difference between the mean values of all vital signs assessed in the study between the patients who needed hospitalization and those who were not hospitalized, and those who were discharged or transferred, and those who died ($p<0,0000$).

About this, studies have evaluated the predictive value of vital signs on arrival at the emergency department and the clinical evolution of the patients. SBP lower than 90 mmHg or greater than 180 mmHg, for example, was a predictor of the need for hospitalization in an emergency department[13]. It is estimated that mean arterial pressure, SBP and oxygen saturation measured in patients injured on arrival at the emergency department are able to predict the evolution of the disease in these patients. Changing these vital signs increases the chance of hospitalization[2].

In contrast, a study in England showed that the majority of patients admitted to the emergency room would not be identified as critically ill with the aid of vital signs assessment, even for patients who were admitted to intensive care compared with those screened by MTS[14]. In this direction, another study identified that, of the patients admitted to an emergency department with all the vital signs within the parameters considered normal, 31% presented deterioration

of the clinical state in the first 24 hours, and the vital signs that changed the most were the HR and oxygen saturation[15].

Systematic review of the literature was carried out with the objective of evaluating the clinical relevance of the routine measurement of vital signs - body temperature, HR, RR, oxygen saturation, and blood pressure - in clinical and surgical patients hospitalized for prediction of mortality, septic or circulatory shock, admission to an intensive care unit, bleeding, need for a new surgical intervention, and occurrence of infection. The results suggest that the measurement of these vital signs is relevant for the identification of the analyzed outcomes. Nevertheless, the authors of the study reinforce that the subject is still little studied, and that studies with greater methodological rigor should be conducted in order to investigate the clinical relevance of the vital signs routinely evaluated by the nursing team[16].

These findings reinforce that further research is needed to determine whether enhanced vital signs surveillance can help prevent deterioration or mortality among patients in the emergency department.

It should be highlighted the difficulty of finding publications with the same central objective of this study, that is, investigating the association between vital signs measured on arrival at the emergency department and the risk levels of MTS, especially in adults. Such publications would allow comparing realities and to deepen data analysis.

CONCLUSION

An association was found between severity levels and vital signs measured at the patient's entrance to the emergency department. The higher the level of severity of MTS, the greater the variability of the mean of the vital signs evaluated, indicating that more severe patients tend to present a greater variation of the vital signs. In general, larger means were found in the values of the vital signs evaluated, depending on how higher the MTS priority level is. Thus, although no causal effect can be inferred, it can be stated that variations in vital signs are related to the levels of risk established in the MTS.

A significant association was found between the means of vital signs between the groups that needed and those that did not require hospitalization, and between those who were discharged or transferred, and those who died. However, it is noteworthy that the existing literature is scarce and not conclusive regarding the importance of measuring vital signs to predict the need for hospitalization and the clinical evolution of patients in emergency departments.

Therefore, new studies are recommended to confirm the existence of association of vital signs and the risk levels of MTS, and the predictive value of vital signs regarding the clinical evolution of patients in emergency departments.

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