ORIGINAL ARTICLE

Use of National Early Warning Score and Perfusion Index in Predicting Outcomes of Elderly Emergency Department Patients

Acil Servise Başvuran Geriatrik Hastaların Sonlanımın Tahmininde National Early Warning Score ve Perfüzyon İndeksi Kullanımı

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ABSTRACT

Objectives: Vitals are the most important parameters for assessing a patient's status and the National Early Warning Score helps to assess vitals to predict how urgent a patient's condition is. The perfusion index is the ratio of the pulsatile blood flow to the non-pulsatile/static blood flow in a patient's peripheral tissue. We aimed to investigate the relationship between National Early Warning Score and perfusion index in the courses and evaluate whether NEWS and PI are useful in predicting outcomes of older patients in an Emergency Department.
Method: In this prospective cross-sectional study, we evaluated non-traumatized older patients admitted to an Emergency Department. National Early Warning Score, perfusion index and patients' Emergency Department outcomes were recorded.
Results: A total of 967 patients (55% female, mean age=74.8) were enrolled. The initial National Early Warning Score of the patients had a significant, negative correlation with perfusion index (p <0.001). Patients admitted to the hospital had higher National Early Warning Score and lower perfusion index values than those discharged (both p <0.001). Patients admitted to an ICU had significantly higher National Early Warning Score and lower perfusion index values than those admitted to the medical floor (both p <0.001).
Conclusion: The National Early Warning Score and the perfusion index are useful instruments to distinguish critically ill elderly patients in an Emergency Department.

Key words: Emergency department, Early Warning Score, Perfusion index, Elderly.

ÖZ

Amaç: Vital değerler, bir hastanın durumunu değerlendirmek için en önemli parametrelerdir ve National Early Warning Score, hastanın durumunun ne kadar acil olduğunu tahmin etmek için vital parametrelerle değerlendirilmesine yardımcı olur. Perfüzyon indeksi, bir hastanın periferik dokusundaki pulsatil kan akışının pulsatil olmayan/statik kan akışına oranıdır. Bu çalışmada National Early Warning Score ile perfüzyon indeksi arasındaki ilişkiyi ve acil servise başvuran yaşlı hastaların sonlanımlarını tahmin etmede National Early Warning Score ve perfüzyon indeksinin yararlı olup olmadığını değerlendirmeyi amaçladık.
Yöntemler: Bu prospektif kesitsel çalışmada, acil servise travma dışı nedenlerle başvuran yaşlı hastaları değerlendirdik. National Early Warning Score, perfüzyon indeksi ve hastaların acil servis sonlanımları kaydedildi.
Sonuçlar: Toplam 967 hasta (%55 kadın, ortalama yaş=74.8) kaydedildi. Hastaların başvuru anındaki National Early Warning Score ile perfüzyon indeksi arasında anlamlı, negatif bir korelasyon vardı (p < 0.001). Hastaneye yatırılan hastalar taburcu edilenlere göre daha yüksek National Early Warning Score ve daha düşük perfüzyon indeksi değerlerine sahipti (her ikisi içinde p < 0.001). Yoğun bakım ünitesine yatırılan hastalarda, servise yatırılanlara göre önemli ölçüde daha yüksek National Early Warning Score ve daha düşük perfüzyon indeksi değerleri vardı (her ikisi içinde p < 0.001).
Tartışma: National Early Warning Score ve perfüzyon indeksi, acil serviste kritik durumdaki yaşlı hastaları ayırt etmek için kullanılabilecek faydalı araçlardır.

Anahtar kelimeler: Acil Servis, Erken Uyarı Skorlamaları, Perfüzyon İndeksi, Geriatri

Introduction

Time is of the essence in the Emergency Department (ED). Diagnosing fast could save a life. Vital signs are the most important indicator of disease severity in ED (1). Typically, emergency room physicians review a patient's vital signs before actually seeing the patient. A quick, effective assessment tool would be of vital importance in prediction of illness severity and the general condition of the patient and early outcome (2,3). Some physiological variables routinely measured in ED are used to classify patients (4). The National Early Warning Score (NEWS), like many existing Early Warning Score (EWS) systems, is based on a simple scoring system in which a score is allocated to physiological measurements already undertaken when patients present to, or are being monitored in hospital (3). Six simple physiological variables form the basis of the scoring system: i) respiratory rate ii) oxygen saturations iii) temperature iv) systolic blood pressure v) pulse rate vi) mental status. The calculated NEWS helps to perform the clinical risk classification in the emergency patient, which also guides setting up the clinical follow-up (3). NEWS proves to be more accurate than the other 33 EWS in detection of combined consequences of cardiac arrest, need for admission in the Intensive Care Unit (ICU) and patients with a high risk of mortality (2,5,6). NEWS was found to be more sensitive than other scores

in diagnosing critical deterioration in patients and consequently in detecting the level and frequency of clinical monitoring (3).

Circulation and respiratory system are the most important systems that an ED physician should check first. Those two vital systems work together to supply oxygen in blood to ensure peripheral perfusion. If we can measure peripheral perfusion directly, it may help ED physicians to understand the patient's condition quickly. Perfusion Index (PI) is the ratio of the pulsatile blood flow to the non-pulsatile/static blood flow in a patient's peripheral tissue. PI, can give an idea to the clinicians on the hemodynamic condition of ED patients by making a non-invasive and continuous measurement with the pulse oximeter possible (7). Hemodynamic variables in critical patients who can not respond to ischemic stimulus because of endothelial and arteriolar smooth muscle damage may not represent the peripheral blood flow properly (8). Recent researches recommend PI be used as an adjunctive method to evaluate the perfusion state of adult patients and determine the disease severity (9-12). There are few data on PI and in particular, there is a need for research that includes large groups of patients like ED patients. PI is an practical and fast measurement of tissue perfusion which may help us to understand a patient's condition without the need of NEWS calculation.

Geriatric patients were found to comprise 14% to 21% of ED admissions and keep increasing over the years, which may be the result of an increasing elderly people population (13). There is a lack of medical condition scoring for elderly patients that PI may give us more information about their critical condition. We aimed to investigate the relation between NEWS and PI in the assessment of elderly patients in ED and to evaluate their association with regard to the outcomes of the patients.

Material and Methods

The research was conducted as a single-centered, prospective, cross-sectional and descriptive study. The research protocol was approved by the local ethics committee of the Health Sciences University, Istanbul Training and Research Hospital (Decision Date: 11 March 2016, No: 798). This study enrolled all patients with 65 years and older admitted to ED between March 2016 and May. Informed consent was obtained from all participants. Exclusion criterias were as follows; patients who underwent cardiopulmonary resuscitation, transferred to another hospital for an emergency operation or further treatment, were unable to communicate, admitted with trauma and those whose vital signs were not available in the records. Among the 1392 patients admitted to ED during the study period, 425 patients (30.5%) were excluded from the study for various reason, and thus the analyses were conducted with the remaining 967 patients (Figure 1).

The physiological variables which are necessary

for the NEWS were obtained from the charts. As recommended by the Royal College of Physicians, the patients were grouped into the following three trigger levels/risk categories based on NEWS: low risk group (NEWS 0-4); medium risk group (NEWS 5-6); and high risk group (NEWS ≥7)(3). As an exception, a single physiological parameter scoring 3 points (max score for a parameter; RED score) reclassifies the low risk patient as medium risk. The patients' mental status was evaluated by the Alert Verbal Painful Unresponsive (AVPU) scoring system. If the patient needed oxygen by a mask or a nasal cannula, 2 points were added (3). Oxygen saturation probe of the pulse oximetry device Massimo-SET Root 7362A RDS7 was used to measure oxygen saturation concurrent with PI with the non-dominant hand maintaining fourth distal phalanx in horizontal alignment with the heart for 30 seconds (7). The outcomes such as discharge, admission to hospital (floor or ICU) and death were tabulated as well.

Statistical analysis

The SPSS Version 21.0 (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.) was used for statistical analysis. Descriptive statistics were presented as figures and percentages for categorical variables and mean value, standard deviation and range for numerical variables. When conditions for normal distribution were not met, comparisons for two independent groups were performed using Mann Whitney U test and comparisons for more than two independent groups were made using Kruskal Wallis test. Subgroup analysis was made using Mann Whitney U test and interpreted using Bonferroni correction. Since parametric testing conditions were not provided, relationships between numerical variables were studied using Spearman Correlation Analysis. Categorical variables recorded within groups were compared using Chi-Square Analysis. The cut-off values were investigated with receiver operating characteristic (ROC) curve analysis. P-values below 0.05 were considered statistically significant.

Results

The median age of the patients was 74 (range 65-97) and 553 (55.1%) of the patients were female. Clinical features of the patients are presented in Table 1.

The mean NEWS of the samples was 2.78±3.75 (95%CI: 2.54-3.02) (range 0-20). The mean PI values of the patients was calculated as 4.57±2.59 (95% CI: 4.41-4.73) (range 0.13-15.0). (Table 2).

The patients had negative, strong statistically significant correlation between PI value and initial NEWS (rho:-0.815, p<0.001) (Figure 2). According to the clinical risk classification based on NEWS, 716 patients (74.0%) were classified as a low risk group, 83 patients (8.6%) as a medium risk group and 168 (17.4%) as a high risk group. The PI value among those groups were found statistically significantly different (p<0.001 for each comparison) (Table 2). Patients in the high risk group had lowest PI value and vice versa.

There was a statistically significant negative weak correlation between PI values and age of patients, and a negative strong correlation between PI values and the number of RED parameters (p<0.001 both). However, NEWS had a statistically significant positive correlation with the age of patients and the number of RED parameters (p<0.001). There was no correlation between the ages of the patients and the number of RED parameters (p=0,055). (Table 3).

Of patients, 232 (24.0%) were admitted to hospital and four (0.4%) died in the ED. Mean NEWS of the admitted patients were significantly higher than those who were discharged (p<0.001). On the other hand, the mean PI value of the admitted patients were significantly lower than those who were discharged (p<0.001) (Table 4). The rate of hospitalization was statistically significantly different among the three groups (p<0.001) (Table 5). Patients in moderate and high risk groups had higher rates of admission to hospital (p). The patients who were admitted to the medical floor had significantly lower NEWS (5.02±3.79, 95% CI, 4.43-5.62) than those admitted to the ICU (9.24±4.52 ,95% CI ,8.17-10.31 P<0.001). On the contrary, the patients admitted to the ICU (1.73±1.39, 95% CI, 1.40-2.06) had statistically significantly lower PI value than those admitted to medical floor (3.12±2.34, 95% CI 2.75-3.48) than those (P<0.001).

The PI cut-off value of 2.35 was able to differentiate low and medium risk groups (ROC analysis, 94% sensitivity, 90.4% specificity). The cut-off value of PI between the discharged and admitted patients was 3.35 (ROC analysis, 79.2% sensitivity, 70.5% specificity). On the other hand, the cut-off of NEWS for admission to hospital was 1.5 (ROC analysis, 81.5% sensitivity, 70.7% specificity).

Table 1: Past Medical history and the systems related to the chief complains of patients

Past Medical History	N (%)	Chief Complain	N (%)
Hypertension	688 (71)	Cardiovascular System	72 (7.4)
Diabetes mellitus	318 (32.9)	Resiparoery System	128 (13.2)
Coronary Artery Disease	233 (24.1)	Gastrointestnal System	199 (20.6)
Congestive Heart Failure	143 (14.8)	Central nervous System	130 (13.4)
Arrhytmia	56 (5.8)	Muscle/Bone System	104 (10.8)
Asthma / COPD	178 (18.4)	Genitourinary System	65 (6.7)
Chronic Kidney Disease	74 (7.)	Ear-Nose-Throat	46 (4.8)
Cerebrovascular Accident	37 (3.8)	Others	44 (4.6)
Dementia	27 (2.8)	Multisystem	179 (18.5)
Cancer	117 (12.1)		

Table 2. Mean Perfusion index values in clinical risk classification groups regarding NEWS.

NEWS clinical risk classifications	PI (Mean±SD)	95 %CI	P*
Low	5.55±2.23	5.39-5.71	<0.001
Medium	2.50±0.99	2.28-2.71	<0.001
High	1.42±0.77	1.53-1.38	<0.001

* Kruskal Wallis

Table 3. Correlation of the patients' ages and the number of RED variables identified in the patients with NEWS and Perfusion index.

	The patients' ages		Number of RED variables	
	rho	p*	rho	p*
Number of RED variables	0.062	0.055		
NEWS	0.115	<0.001	0.610	<0.001
Perfusion index	-0.089	<0.001	-0.600	<0.001

* Spearman's Correlation analysis

Table 4. Mode of ED dispositions of the patients in relation with NEWS and Perfusion index.

Mode of dispositions	NEWS (Mean±SD)	95% CI	P*	PI (Mean±SD)	95% CI	P*
Discharge from ED	1.59±2.46	1.41-1.77		5.19±2.39	5.02-5.36	
Admission to Hospital	6.31±4.47	5.74-6.89		2.69±2.19	2.41-2.97	
Death in the ED**	15.00±4.24	8.25-21.75	<0.001	0.59±0.32	0.07-1.10	<0.001

* Kruskal Wallis test ** Excluded from analysis

Table 5. Distribution of patients' ED disposition respecting NEWS clinical risk classifications.

ED disposition	Patients with low risk (n,%)	Patients with medium risk (n%)	Patients with high risk (n%)	P
Discharge from ED	640 (89.4)	44 (53.0)	47 (28.0)	
Admission to Hospital	76 (10.6)	39 (47.0)	117 (69.6)	<0.001
Death in the ED**	0 (0)	0 (0)	4 (2.4)	

** Excluded from analysis
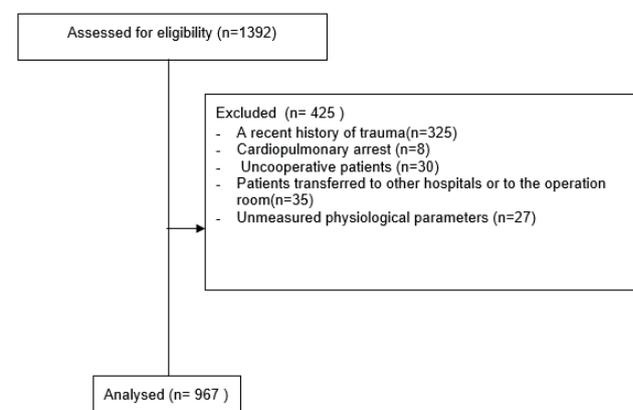
Figure 1. Flow chart (CONSORT diagram) of the included and excluded patients in the study.
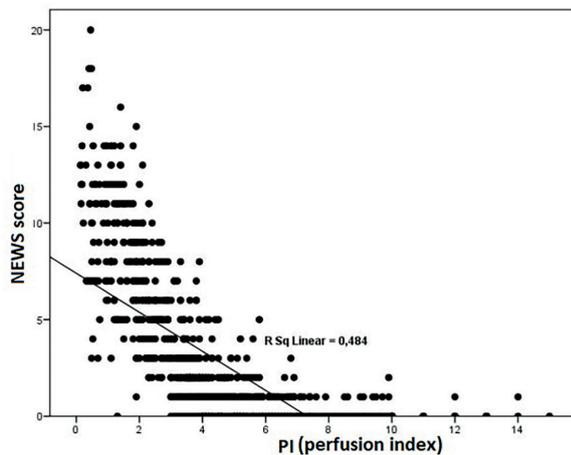
Figure 2. The Correlation Between NEWS and PI

Discussion

We found that PI value was significantly correlated to the critical groups based on initial NEWS. Likewise, mean PI values of the three clinical risk classification groups according to the patients' NEWS were found significantly different. There are few studies in the literature regarding practical and non-interventional methods for EWS such as NEWS and PI in order to evaluate elderly patients more objectively and thoroughly in a short time. Pirneskoski et al. did similar research by using modified Early Warning Score (mEWS) and pulse photoplethysmography. mEWS is a tool for bedside evaluation based on five physiological parameters: systolic blood pressure, pulse rate, respiratory rate, temperature and AVPU score. They divided patients into two groups based on mEWS such as critically ill (mEWS>3) and non-critically ill (mEWS≤3). They used pulse photoplethysmography amplitude to evaluate peripheral perfusion value (14). On the contrary, we obtained peripheral perfusion index by a pulse oximetry device (Massimo Root) which gives a numerical result instead of categorical results. They demonstrated that peripheral perfusion value was significantly correlated with mEWS in critically ill patients (14).

In this study, the NEWS was significantly higher in admitted patients than those discharged from ED. Moreover, the mean NEWS was statistically significantly higher in patients admitted to ICU than those admitted to the medical floor. High NEWS was also found to be correlated with a higher risk of ICU admission. We showed that the NEWS accurately identified high-risk patients, and this study is compatible with the literature. Abbott et al. reported a significant correlation between the patients' NEWS and their admission to ICU and in-hospital mortality (15). Shaw et al. reported that patients died or admitted to ICU had higher NEWS than those admitted to a medical floor or discharged from ED (16). Kim et al. found that higher NEWS show acceptable predictive ability for ICU admission and in-hospital mortality (6).

In this study, disposition status was statistically significantly different among clinical risk groups based on NEWS. Patients with medium and high risk groups had higher admission rates than the patients with low risk groups. Alam et al. found a significant correlation between initial NEWS and clinical outcomes (17). Moreover, Armagan et al. demonstrated that mEWS of 5 and greater successfully distinguished critical patients who had a high percentage of ICU admissions and mortality rate (18). This study is compatible with the literature. On top of that, our study has shown that NEWS is a useful instrument to distinguish critically ill older patients in ED.

We found that the patients admitted to hospital had much lower PI values than those discharged. Moreover, the patients admitted to ICU had significantly lower PI values than those admitted to the medical floor. We showed that the need for admission to ICU was inversely proportional to the PI values. Lima et al. reported that critically ill patients who had higher Sequential Organ Failure Assessment (SOFA) scores and higher level of lactate had low PI value. Additionally, patients with low peripheral perfusion had faster ensuing, organ failure (19). Another study on post-return of spontaneous circulation (ROSC) patients showed that lower PI values were associated with 30-day mortality or poor neurologic outcome (11). Acar et al. demonstrated that PI could be used to predict the mortality or discharge in ICU patients (20). Our study supports the findings of the previous studies and indicates that PI is a useful parameter that distinguishes critically ill older patients in the ED as does NEWS. PI also can be very useful to predict the outcome of the patients admitted to ICU.

The most important difference of this study from the previous ones is PI values which gives us an objective result. We found that the 2.35 cut-off value of PI differentiate low risk groups and medium risk groups. Additionally, and most importantly we determined that PI values of 3.35 or greater predicted 80% of the discharged elderly patients from ED. There was only one study in literature which obtained cut-off value for PI. They took the cut-off value of PI as 2.35 which predicted 94.1% of the discharged in the ICU (20). However, our study is the only study in literature which assessed elderly patients which is essential because it can be difficult to obtain history from elderly patients in ED.

In this study, NEWS and PI values in elderly patients showed a strong negative correlation. Further, low PI values and high NEWS values have strong predictive power when it comes to ED outcomes like hospitalizations. In a study by Akdur et al., 655 consecutive COVID-19 patients admitted to the emergency department were studied for poor outcomes (mortality) combined with NEWS, PI, and other tools. NEWS and PI values were significantly correlated with time-to-death within 14 days and 90 days of their study (12). To assess adult patients at risk

for clinical decline, Sebat et al. combined capillary refill time and EWS. A prolongation of capillary refill time was found associated independently with increased hospital mortality, transfer to higher levels of care, and length of stay (21). Performing a peripheral perfusion measurement is quick, easy, and can contribute greatly to vital signs. Combining it with an early warning score has been shown to help identify patients with a worse prognosis.

Limitations

This study had some limitations. First, our study was performed at a single center and enrolled patients only in elderly patient group. So we could not compare the elderly patient to other age groups. Additionally, we have not investigated further outcomes of the ICU and medical floor.

Conclusion

Our study demonstrated the negative strong correlation between the NEWS and PI values in elderly patients. Moreover, high NEWS and low PI value have strong predictive power on ED outcomes such as admission to hospital. PI is an easily measured and practical parameter which can be used in emergency settings to differentiate critically ill elderly patients who need immediate attention and admission. We suggest that future studies may compare elderly patients with other age groups.

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