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RESEARCH ARTICLE

Use of Tissue Oxygen Saturation Levels as a Vital Sign in the ED Triage

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ABSTRACT

Objectives: The utilization of vital signs as triage tools remains a mainstay ofemergency patients. The evolution of monitoring technologies, including the noninvasive tissue oxygen saturation devices has improved our ability to monitor the critically ill patients. The aim of the present study was to determine the tissue oxygen saturation (StO2) levels of the patients as a vital sign during emergency triage.

Methods: Approximately 30-35 patients present to our emergency department each day and the triage of these patients are performed by a nurse at admission time. A three level system (1: red, 2: yellow, 3: green) is used to determine the triage level of the patients presenting to our department. We examined 150 patients during five days. Age gender, triage levels and hospitalization status of the patients were noted. For the StO_2 level measurement, an Inspectra device was placed to the right thenar muscle for 10 s and mean of the first, fifth and 10th second values were noted at the admission time.

Results: In our study 73 females (48.6%), 77 males (51.4%) totally 150 patients were included. We determined a significant difference between green and yellow (p=0.00), green and red (p=0.00), yellow and red (p=0.001) according to StO_2 levels. We couldn't find a significant difference between females and males in triage groups (p=0.13 for green, p=0.71 for yellow, p=0.86 for red). There was correlation between StO_2 - triage level (p=0.00, r=0.609) and StO_2-hospitalization status (p=0.00, r=0.449).

Conclusion: StO2 level measurement may be helpful in determining the triage level of the patients presenting to the ED.

Keywords: emergency, tissue oxygen saturation, triage

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INTRODUCTION

Emergency departments (ED) have to consider new and effective methods to promptly identify and treat the critically ill or potentially critically ill patients because of dramatic increases in patient volumes. Rapid identification of critically ill patients could be imperative for the outcome [1]. Most of the current triage tools in use are based on a categorical measurement acuity scale [2,3]. In practice, the use of a rapid triage system within an ED diminished the time period of arrival-to-triage and improved throughput of the nonurgent patient [4]. The clinical assessment of patients in the ED is based in part upon the measurement and interpretation of initial vital signs. Emergency physicians and nurses usually use vital signs as markers of the severe illness, determining triage categories and directing more immediate attention to those patients with abnormal vital signs [5].

Monitoring of early regional ischemia may be more helpful to provide early intervention given that an ischemic injury is reversible. Continuous and noninvasive techniques for tissue ischemia monitoring have been studied recently but there is a limited data in literature. Lack of agreement between bioimpedance and continuous thermodilution measurement of cardiac output in intensive care unit patients [6]. Physicians have been used near-infrared spectroscopy (NIRS) device for hypoxemia and ischemia which permits noninvasive, continuous monitoring of tissue

Table 1. Age, StO2 levels and hospitalization status of the groups accoring to gender

	Green (n:58, 38.7%)		Yellow (n:43, 28.6%)		Red (n:49, 32.7%)	
	F (n:35,47.9%)	M (n:23,29.9%)	F (n:18,24.7%)	M (n:25,32.5%)	F (20,27.4%)	M (n:29,37.7%)
Age	29.14±13.84 (min:18,max:65)	37.47±16.57 (min:23,max:70)	54.72±13.21 (min:40,max:75)	53.04±16.95 (min:18,max:75)	57.90±15.87 (min:18,max:75)	56.03±14.65 (min:22,max:80)
StO_2 (%)	74.69±1.54 (min:70,max:76)	76,09±2.64 (min:72,max:80)	80±5.15 (min:73,max:87)	79.88 ±4.04 (min:75,max:87)	83.15±8.67 (min:62,max:93)	82.76±7.16 (min:67,max:92)
Hospitalization						
Discharged (n:102, 68%)	n:58 (100%)		35 (81.4%)		9 (18.4%)	
Hospitalized into service (n:17, 11.3%)	n:0 (0%)		8 (18.6%)		9 (18.4%)	
Hospitalized into ICU (n:31, 20.7%)	n:0 (0%)		0 (%)		31 (63.3%)	

hemoglobin oxygen saturation (StO2) in muscle [7,8]. At the beginning, it had been used by neurologists and neurosurgeons just for brain and other large organs [9,10]. NIRS has also been used in critically ill patients especially in intensive care units and studies about NIRS have still been going on for its efficacy and new fields for its usage [11-13]. Near-infrared spectroscopy (NIRS) provides noninvasive measurement of StO_2 within the microcirculation [14]. NIRS has also been used to determine the severity of hemorrhagic shock, as a guide for fluid resuscitation, in septic shock, and predicting multiple-organ dysfunction syndrome [8,9,15,16].

However, data is limited about the Sto_2 levels as a vital sign in triage among patients presenting to ED [17-19].

Aim: The aim of the present study was to determine the StO2 levels of the patients as a vital sign during emergency triage.

METHODS

Approximately 30-35 patients present to our emergency department each day and the triage of these patients are performed by a nurse at the arrival time. A three level system (1:red (emergency), 2:yellow (urgent), 3:green (nonurgent)) is used to determine the triage level of the patients presenting to our department. The diagnoses of the patients were not used in the study, we just wanted to determine the StO_2 levels according to the triage level. For this study approval of the Human Study Committee of our medical faculty was provided. The participants/relatives were informed and gave their informed consent. We examined 150 patients during five days. Age gender, triage levels and hospitalization status of the patients were noted. For the StO_2 level measurement, an Inspectra device was placed to the right thenar muscle for 10 s and mean of the first, fifth and 10th second values were noted at the admission time. In our study, we measured thenar muscle StO_2 via NIRS (InSpectra; Hutchinson Technology). Cardiopulmonary arrest patients and patients under 18 age were excluded from the study.

Statistical Analysis

The normal distribution and homogeneity of each parameter were tested using the Shapiro–Wilk test and the Kolmogorov–Smirnov test. Age and STO_2 values did not suit the normal distribution. A Mann Whitney-U test was used for differences between triage level groups. A Spearman correlation test was used for correlation analysis. In all tests the significance level was $p<0.05$. SPSS (Statistical Package for the Social Sciences) software 20.0 was used for analysis.

RESULTS

In our study 73 females (48.6%), 77 males (51.4%) totally 150 patients were included. The mean age of our study group was 46.50±18.89 (min:18, max:80). Mean age of the females was 43.32±19.68 (min:18, max:75). Mean age of males was 49.51±5.80 (min:67, max:92). Mean StO_2 levels of triage groups were 75.24±2.14 (min:70, max:80) for green, 79.93±4.48 (min:73, max:87) for yellow, 82.92±7.73 (min:62, max:93) for red triage categories. Detailed age, StO_2 levels and hospitalization status of the groups according to gender is given in **Table 1**. We determined a significant difference between green and yellow (p=0.00), green and red (p=0.00), yellow and red (p=0.001) according to StO_2 levels. We couldn't find a significant difference between females and males in triage groups (p=0.13 for green, p=0.71 for yellow, p=0.86 for red). There was correlation between StO_2 - triage level (p=0.00, r=0.609) and StO_2-hospitalization status (p=0.00, r=0.449).

DISCUSSION

In our study, we determined a significant difference between green and yellow, green and red, yellow and red according to StO_2 levels. But we couldn't find a significant difference between females and males in triage groups. There was correlation between StO_2 - triage level and StO_2-hospitalization status. Patients with elevated StO2 levels were hospitalized into a clinic and ICU.

Sagraves et al. investigated the Hutchinson Technologies' InSpectra STO2 monitor in the prehospital arena with respect to ease of use by emergency providers to correlate STO2 measurements with patient outcomes. In their study, they included 48 patients and compared the average Injury Severity Score (ISS), hospitalization status including hospitalization day and StO2 levels. They reported that STO2 endpoints were significantly different between patient groups having an ISS<25 versus ISS >25. STO2 endpoints were not related with Glasgow Coma Scale, ventilator days, ICU days, or hospital days. In that study, first and endpoint StO2 levels were significantly different between survivors and non-survivors. They reported that the measurement of STO2 in the field is easy and the NIRS technology holds the potential to be a resuscitative adjunct with the ultimate goal to allow emergency personnel to have a non-invasive monitor of hypoperfusion in the field and the early detection of resuscitation need during post-injury period [20].

Similarly, Guyette investigated whether prehospital tissue oximetric values could predict the need for in-hospital LSI (life saving interventions), defined as the need for emergent operation or emergent transfusion in the first 24 hours of hospitalization. They applied the StO2 device in a convenience sample of 150 trauma patients transported by a single critical care transport service. They measured StO2, deoxygenation and reoxygenation levels of the patients. In their study the initial mean StO2 level was 78. Prehospital deoxygenation was associated with need for LSI in their study population. Guyette reported that further studies of deoxygenation were needed for determining whether it could be used as a triage criterion or an endpoint for resuscitation [21].

Contraversial to our study, Bazerbashi et al. suggested that low StO2 levels predict the intensive care unit admission. They studied in 158 cancer patients (a specific patient group). It may show that StO2 levels may have a range similar to Ph. Further studies are warranted to determine the limits. In our study, similar to Bazerbashi's study there were values under 70 and those were admitted to the intensive care unit via red level. But this didn't change the statistics. They ve suggested that tissue oxygen saturation at triage identifies critical patients who may not be recognized by vital signs alone and issue oxygen saturation measurement could help providers make earlier decisions regarding hospital resource allocation [17].

NIRS was used to determine whether NIRS-derived StO2 measures (StO2 initial, StO2 occlusion and StO2 recovery) identify patients who are in shock and at increased risk of organ dysfunction (Sequential Organ Failure Assessment (SOFA) score ≥ 2 at 24 hours) and dying in the hospital. This prospective study had been perfomed in 168 ED patients. According to the results NIRS measurements for the StO2 initial, StO2 occlusion and StO2 recovery slope were abnormal in patients with septic shock compared to sepsis patients [22]. Martin et al. hypothesized that NIRS derived StO2 could assist in identifying shock in 115 casualties arriving to a combat support hospital and predict the need for life-saving interventions (LSIs) and blood transfusions. They included 147 combat casualties. In their study, NIRS-derived StO2 obtained on arrival predicts the need for blood transfusion in casualties who initially seem to be hemodynamically stable (SBP >90) [23].

CONCLUSION

StO2 level measurement is an easy noninvasive technique and this method may be used as a vital sign and may be helpful in determining the triage level of the patients presenting to the ED. Further comprehensive studies are warranted on StO2 usage especially in five level triage ED systems.

Declaration of interest: The authors report no conflicts of interest.

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