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Review of Early Warning Scoring System as a Primary Diagnostic Tool in Critically ill Patient

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Abstract

In order to provide immediate and urgent care to the critically ill patient, there is an overwhelming need for efficient and well-prepared guidelines for the emergency service provider. This paper presents survey on the available early warning scoring (EWS) systems and their effectiveness as a primary decision-making tool. Most of the EWS system relies on several physiological parameters. The calculation of the aggregate score based on prescribed parameters gives the estimation about the current health status of the patient. Based on the calculated score the clinical person can take the appropriate decision for initiating the primary treatment. EWS plays vital role almost at each and every place in the clinical service. Timely prediction of the deterioration in health can be a lifesaving for the ICU patient. Early decision of initiating a therapy in emergency is considered as one of the key parameters. In addition to Intensive Care unit (ICU) and Emergency Department (ED) scoring system, Pre-Hospitalization (PH) is another sector which is also equally important in improving health care service in emergency situation. By considering all these factors, we hereby present the review of few available and widely used EWS. This review focuses on their possible effects on facilitating the clinical diagnostic process.

Keywords: Early Warning Scoring System (EWS), ICU (Intensive Care Unit), ED (Emergency Department), PH (Pre-Hospitalization)

INTRODUCTION

Clinician and researcher require robust method for prediction in critically ill patient. There are varieties of scoring system developed for this purpose in intensive care unit (ICU), emergency department (ED), and pre-hospitalization (PH). ED based scoring system considers lesser parameters which are readily available from the patient, while ICU scoring system includes more parameters which are generally available from patient admitted in ICU. Pre-hospitalization based scoring system is also designed in line with the ED scoring system.

Generally, it is believed that the scoring system with larger number of parameters should perform better than lesser parameter-based scoring system. But in some cases, scoring system with lesser number of parameters performs better than system with higher number of parameters if the population is well defined. Furthermore, some of the ED-based scoring system performs even better in ICU as compared to ICU scoring system. Pre-hospitalization scoring system also includes lesser parameters and used to define the level of criticality in the patient as a part of primary decision-making process.

In this paper, we have considered few models amongst ICU, ED, and PH scoring system. For ED-based, we have considered modified early warning scoring system (MEWS) and national early warning scoring system (NEWS). For ICU - based, we included review on APACHE-II and APACHE-III scoring system. For PH, we have included PHEWS scoring system [1].

SCORING SYSTEM

There are many ICU based systems available for the primary assessment of the patient's condition. APACHE-II system, simplified version of original APCHE (acute physiology and chronic health evaluation), is one of the most widely used ICU based systems [2]. In order to predict the risk of mortality with higher accuracy, Knaus et. al. developed another system known as APACHE III [3]. Compared with the APACHE II systems, the APACHE III system employs more variables and is more complex and time-consuming in decision making.

The scoring systems are the primary tool for decision making process in absence of observation of continuous observer or primary clinical service provider. APACHE systems are used to calculate the weighted score of individual physiological parameter to generate the final Acute Physiological Score

(APS). Amongst many parameters included APACHE-II, here weighted score of one parameter (Body Temperature) on a scale of 0 to 4, is shown below:

Table 1: weighted score Body Temp. in APACHE II

Weighted score	Temperature range (^oC)
4	**< 30**
3	**30 – 31.9**
2	**32 – 33.9**
1	**34 – 35.9**
0	**36 – 38.4**
1	**38.5 – 38.9**
3	**39 – 40.9**
4	**> 40.9**

APACHE is a reliable and useful means of classifying ICU patients based on their APS score. Original APACHE system was very much complex. So APACHE II was the simplified yet statistically accurate model for clinical assessment of ICU patient.

In APACHE II, the number of physiological parameter they have reduced up to 12, As compared to original APACHE, this modified version has got lesser parameter. The established method was validated for the purpose of disease severity classification system in hospital. APACHE II was tested in varieties of patient with different diseased condition [3]. This EWS was proved to be effective if the analysis will be done at early point of time, it means in the emergency room or at the time of ICU admission. In this new modified version of APACHE, they also proposed few changes in thresholds and weights for the physiological parameters. Unlike APACHE, it is mandatory to measure all 12 physiologic values for calculating the score index in APACHE II. Age and severe chronic health problems are also incorporated in APACHE II. The maximum possible APACHE II score in 71. In this scoring system the score will be calculated without considering the disease category.

The development of APCHE III was based on the acute variations in patient's physiological values and short-term risk of death. This prognostic system consists of two options: (i) APACHE III score, provides initial risk stratification and (ii) APACHE III predictive equations, uses APACHE III score and reference data on disease categories to provides risk estimates for hospital mortality for individual patients. In order to determine the primary reason for ICU admission, they developed a list of 212 disease categories. So after admission in ICU, within 24 hours, the patient will be allocated to one particular disease category based on its existing medical situation. They included 20 physiological parameters to access the severity of disease. Most of the APACHE systems are developed for mortality prediction, but in APACHE III system also indicates the patient's therapeutic requirements. But still this system lacks in forecasting the nursing and other care requirements, potential need for unique ICU treatment, anticipated length of ICU and hospital stay [4].

MEWS (Modified Early Warning Scoring System) developed at Heart of England NHS foundation trust for all adult in-patients including located in maternity areas and emergency department. The physiological parameters selected in this system are: temperature, pulse, blood pressure and respiratory rate, with oxygen saturations, level of consciousness and urine output. The aggregate score is then calculated from all seven parameters. Once the score crosses that predefined threshold, then it indicates the required action need to perform. MEWS has a score range of 0 (lowest) to 3 (highest) for each of its 5 parameters, with the composite score from all 5 parameters representing the MEWS.

Studies were carried by different groups for proving the effectiveness of the MEWS system under different situation. One such study carried to prove its applicability in emergency department for Asian people. They also suggested that studying the MEWS score based on only vital sign parameters may not be a good indicator for short or long term clinical outcomes. This scoring system is again not applicable for paediatric study [5].

The NEWS, like many existing 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. Six simple physiological parameters form the basis of the scoring system:

i) Respiratory rate
ii) Oxygen saturation
iii) Temperature
iv) Systolic blood pressure
v) Pulse rate
vi) Level of consciousness

A score is calculated based on the values allotted in table

Table 2: Individual score on NEWS system

Physiological Parameters	3	2	1	0	1	2	3
Respiration rate	≤8		9-11	12-20		21-24	≥25
Oxygen saturation	≤91	92-93	94-95	≥96			
Any supplemental oxygen		Yes		No			
Temperature	≤35.0		35.1-36.0	36.1-38.0	38.1-39.0	≥39.1	
Systolic BP	≤90	91-100	101-110	111-219			≥220
Heart Rate	≤40		41-100	51-90	91-110	111-130	≥131
Level of Consciousness				A			V,P or U

Based on the score calculated using the above table, there is definite thresholds for triggering the clinical response. So, in order to get the estimation about the severity of the patient's condition, they proposed the calculation of aggregate NEWS

score. This aggregate score should trigger a medium and high-level clinical alert as shown below [6].

Table 3: Aggregate score and risk level

NEWS scores	**Clinical risk**
0	Low
Aggregate 1-4	
RED score (Individual parameter scoring 3)	Medium
Aggregate 5-6	
Aggregate 7 or more	High

The PHEWS (Pre-Hospital Early Warning Score) scoring system primarily designed to distinguish between patients who can be managed in the urgent care setting and patients who need admission to the emergency department. This system relies on observation parameters that suggest deviation from normal values. Small changes in individual observations may predict deterioration in the seriously unwell patient. It does not predict patient outcome.

They considered following parameter:

i) Heart rate (bmp)
ii) Respiratory rate
iii) Systolic blood pressure (mmHg)
iv) Oxygen saturation
v) Central nervous system
vi) Temperature tympanic
vii) BM mmol/l (capillary)
viii) Pain score (0-10)

Each parameter will generate a score ranging from 0-3 respectively. Based on the individual score it is obvious to calculate the total score. If the total score is 5 or above, the patient should be taken to the nearest emergency department [7].

Parametric comparison of various EWS is listed in this table. This clearly demonstrates the number of parameters in APACHE-III is more as compared to other EWS system. Few basic physiological parameters are essential to consider in every system considered here.

Table 4: Parametric Comparison of various EWS

Parameters	APACHE III	APACHE II	NEWS	MEWS	PHEWS
Heart rate	√	√	√	√	√
Mean BP	√	√			
Systolic BP			√	√	√
Temp	√	√	√	√	√
RR	√	√	√	√	√
SpO2			√		√
PaO2	√	√			
AaDO2	√	√			
Blood Glucose					√
Age	√	√			
GCS visual	√	√			
GCS speech	√	√			
GCS motor	√	√			
AVPU score			√	√	√
Pain score					√
Urine output	√			√	
WBC	√	√			
Hematocrit	√	√			
pH	√	√			
pCO	√				
Primary comorbidities	√				
Serum creatinine (without ARF)	√	√			
Serum creatinine (with ARF)	√	√			
Serum Na	√	√			
Serum potassium		√			
Serum albumin	√				
Serum bilirubin	√				
Serum glucose	√				
Serum BUN	√				

Parametric Assessment:

The effectiveness of early warning scoring system can be assessed by various parameters. These parameters will give us insight of their clinical importance in the emergency medicine. By going through different resources, following parameters are chosen for the comparative analysis of different EWS listed above [8]:

i) Mortality prediction

In emergency department, triage is used to assess the patient's severity and to assign priorities for treatment. For that purpose, the early warning scoring system can be very helpful for judging the patient's condition. Mortality prediction is considered as one of the most significant parameter in clinical emergency.

APACHE-II is widely accepted as a measure of illness severity. APACHE-II score is relatively found more accurate than other scoring system. But it was not sensitive, specific and accurate enough to predict the patient's exact mortality [9,10].

APACHE-III model includes more number of parameter as compared to earlier version of APACHE. APACHE-III is

derived from a much larger database that contains a large number of post-operative patients and a much larger number of trauma patients. So this system reported to be more accurate in mortality for some specific ICU patient and in some disease condition.

NEWS and MEWS study demonstrated that increased MEWS score is directly associated with mortality in a group of medical emergency admission [15].

ii) Cardiac Arrest

In hospital, the cardiac arrest is always following up by showing signs of clinical deterioration.

APACHE-II score is a modest indicator for in-hospital cardiac arrest while it is poor indicator for out-of-hospital cardiac arrest [9].

APACHE-III is one of the most utilized tools in predicting the severity of illness. It offers moderate accuracy in predicting the probability of cardiac arrest for in-hospital patients.

MEWS can be very useful in finding this clinical deterioration and using this to improving the patient care and monitoring in ward [13,14].

NEWS was evaluated against a range of outcomes that are of major importance to patients and staff. It demonstrates a good ability to discriminate patients at risk of the combined outcome of cardiac arrest, unanticipated ICU admission or death within 24 hours, which provides ample opportunity for an appropriate clinical intervention to change patient outcome.

iii) Hospital Stay

Hospital length of stay is the most important determinant of hospital cost and resource utilization.

APACHE-II and APACHE-III score is a good indicator of length of stay either in hospital or specifically in ICU [9,10,11].

NEWS and MEWS high score may likely occur during the early admission in hospital and falls in the most patient over time which suggest the beneficial effects of treatment. So NEWS and MEWS can act as another method of assessing the efficiency of medical intervention. Indirectly suggesting the length of hospital stay of patient [16].

iv) ICU/ED admission

APACHE-II is primarily used to estimate the risk of death for patients in ICU and patients with Miocardial Infarction (M.I.) and it is not suitable for bed side assessment for emergency along with medical ward patients in a routine manner. Even though by calculating this score it is possible to decide the patient's admission to ICU [9].

NEW and MEWS closely identified the severity of patients admitted to the ICU, suggesting that it can be a reliable score, useful in the situations preceding the ICU.

PHEWS is the system which is specifically designed for this purpose only. Based on the score calculated, The EM-person can decide whether patient should be admitted to ED or shifted to some other ICU/ward.

v) Rapid response

APACHE-II & APACHE-III score also helps to decide the clinical attention needed to the patient.

NEWS scoring system is considered as one of the important part of risk management strategy. When NEWS score is four or more than senior physician should be called immediately. And emergency staff should assess the patient's condition and reevaluate the treatment accordingly.

MEWS can be used in the wards for guidance of a continued follow-up of patients, highlighting that those with changed scores and progressive increase, demand more attention by the team responsible, because there are evidences that early intervention may improve the outcome [12].

vi) Nursing

NEWS and MEWS is simple bedside tool which is helpful for calculated by nursing staff in a busy clinical area. This system facilitates nursing staff to assess the patient's condition in their busy schedule [12].

vii) Clinical deterioration

APACHE-II and APACHE-III system are primarily designed for indicating the severity of disease. By periodically assessing the scores, it helps to identify the health deterioration of patient [9,11].

NEWS and MEWS helps early and more thorough measures and can be promptly enacted to avoid clinical deterioration of the patient because there is a direct relation between presence of a critical score and increasing morbidity/mortality [18].

DISCUSSION

None of the ICU based available scoring system appears to be suitable for bedside assessment of ward patients in a routine fashion [12]. NEWS and MEWS is proven to be a versatile tool in this context. NEWS and MEWS score can be calculated based on few parameters readily measured or recorded.

The ICU based scoring system is based on assessment of more number of patient's physiological parameters and it outperforms in certain cases too. But when patient is in Emergency Department, it is the situation which needs urgent attention and immediate action. For that reason, the decision should be taken from minimum parameters possible. So, the EWS designed for ED should be slightly different and it should include minimum parameters which are mostly measured as a part of emergency procedure [17].

Most of the EWS developed are based on some specific population, so the applicability of those EWS in other population needs to be assessed properly. In some cases, it needs to be developed some dedicated EWS for some specific population too; and verify its efficacy and applicability in that specific region. The accuracy of any scoring system is highly dependent on the quality of the input. Accuracy of decision taken by the system depends on understanding of the definitions of related terms by user, time of data collection, rules used for missing data at the time of collection of data, and so on must exactly match those applied when building the model.

Other than that, models which are responsible for developing the EWS systems are also contributing to the various factors which limits its overall applicability in general scenario. This also needs to be considered while using these systems in clinical environment.

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