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Araştırma Makalesi / Research Article

Model Önerisi / Model Recommendation

Model recommendations for how to prevent cardiac arrest in hospitals

Hastanelerde kardiyak arrestlerin nasıl önlenebileceğine ilişkin model önerileri

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ABSTRACT

Aim: Cardiac arrests are common in hospitals, and delays in treatment have resulted in lower survival and worse neurological outcomes. Evidence shows that patients' physiological parameters begin to deteriorate before cardiopulmonary arrest and vast majority of them can be prevented. The aim of this study is to develop early warning scoring models that will enable early identification of the changes in the physiological parameters of pediatric and adult patients with high risk before cardiopulmonary arrest.

Material and Method: Evidence-based studies on early warning scoring have been reviewed, and model recommendations have been developed for pediatric and adult patients by taking specialist opinions.

Results: An algorithm that includes heart rate, blood pressure, respiratory rate, body temperature, state of consciousness parameters, reference intervals and medical interventions given to the patient has been recommended for adults. For pediatric patients, an algorithm that includes respiratory, circulatory and behavioral / neurological system parameters, reference intervals and medical interventions given to the patient has been recommended.

Conclusion: Early recognition of deterioriation patients reduces mortality, length of stay and costs in hospitals.

Keywords: Early warning system, cardiac arrest

ÖZ

Amaç: Kardiyak arrestler hastanelerde sık görülür ve tedavideki gecikmeler düşük sağkalım ve kötü nörolojik sonuçlara neden olur. Kanıtlar, kardiyak arrestten önce hastaların fizyolojik parametrelerinin bozulmaya başladığını ve bunların büyük bir çoğunluğunun önlenebileceğini göstermektedir. Bu çalışmanın amacı, kardiyopulmoner arrest gelişmeden önce yüksek riskli pediatrik ve erişkin hastaların fiyolojik parametrelerindeki değişikliklerin erken tanımlanmasını sağlayacak erken uyarı skorlama modellerinin geliştirilmesidir.

Gereç ve Yöntem: Erken uyarı skoru ile ilgili kanıta dayalı çalışmalar gözden geçirildi, pediatrik ve erişkin hastalar için uzman görüşleri alınarak model önerileri geliştirildi.

Bulgular: Yetişkin hastalar için kalp atım hızı, solunum sayısı, vücut sıcaklığı ve bilinç durumu parametreleri, referans aralıkları ve hastaya uygulanan tıbbi müdahaleyi içeren bir algoritma önerildi. Pediatrik hastalar için solunum, dolaşım, davranışsal / nörolojik sistem parametreleri, referans aralıkları, hastaya uygulanan tıbbi müdahaleyi içeren bir algoritma önerildi.

Sonuç: Kötüleşen hastaların erken tanımlanması hastanelerde mortaliteyi, hastanede kalış süresini ve maliyetleri azaltır.

Anahtar Kelimeler: Erken uyarı sistemi, kardiyak arrest

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INTRODUCTION

Higher levels of patient expectations, increasing complexity of hospitalized care, and increasing cost of poor patient outcomes, hospital leaders are increasingly interested in management support systems that offer early identification of deteriorating patients (1). Nowadays, evidence showed that people in-hospital were dying or suffer unnecessarily (2), and cardiac arrest continues to be an important health care problem worldwide because of high frequency and low survival (3). Studies have shown that cardiac arrest can be preventable (4-7).

Early recognition of deteriorating patients are important for prevention of further deterioration (7) and improving patient outcomes (8,9). Delays in these process are associated with unplanned admissions to intensive care units (ICU), unexpected deaths and cardiac arrests (10-15). At this point early identification and timely intervention to patients is vital (10). It may be possible to decrease mortality if these patients can be recognised and treated earlier (16). Acute changes in systolic blood pressure, heart rate, respiratory rate, level of consciousness, oxygen saturation, and temperature occur before deterioration and cardiac arrest (17-21). Abnormal vitals often precede inpatient cardiac arrest providing an opportunity for early identification and intervention (22). Timely diagnosis of complications is important to initiate early targeted therapy (23). For this reason, early warning systems(EWS) were developed using a score based on the patient's physiological parameters (22) and to inform the most appropriate clinical response (24).

The aim on the prevention and recognition of patient deterioration has led to the use of EWSs in many countries (25,26). EWSs are designed to determine if the patient's vital signs are within normal ranges. The sum of the allocated points is used to indicate a patient's severity of illness, and to inform the need to increase the patient's physiological monitoring or deliver expert help to their bedside (25).

In total, over 100 EWSs exist (15), in hospitals in the Netherlands, USA, Australia, and the UK (2). The first early warning score developed in 1997 by Morgan, Williams and Wright based on five physiological parameters: Systolic Blood Pressure / Hearth Rate / Respiratory Rate / Temperature / Level of Consciousness (Allert-Voice-Pain-Unconscious) (27).

In 1999, Stenhouse et al. (28) added urine output Modified EWS (MEWS). MEWS, has been proven to be a useful tool for predicting deterioration in physiological parameters of patients. Drower et al. (29) found that the incidence of cardiac arrests per 1000 admissions significantly decreased from 4.67 in 2009-2010 to 2.91 in 2010-2011 after the use of the MEWSs at a 600 bed hospital in New Zealand.

The Royal College of Physicians in London developed an National Early Warning Score (NEWS) in 2012. NEWS is based on seven parameters; respiration rate, temperature, oxygen saturation, systolic blood pressure, any supplemental oxygen, hearth rate, level of consciousness (30). NEWS aims to be prognostic by identifying patients at risk of adverse outcomes (15). NEWS is associated with admission to a critical care unit (level two or three care) and death in studies of patients with cancer, sepsis and medical diagnoses (14).

The first pediatric early warning score (PEWS) was based on adult systems in 2002 and published by Monaghan in 2005 (31). Various pediatric early warning systems have been developed worldwide, and Monaghan's PEWS is one of the flexible and simple systems. It is quickly evaluated, is not age specific, and has five domains; cardiovascular status, behavior, nebulizer use, respiratory status, and persistent postsurgical vomiting. It has been validated in retrospective studies of pediatric hospitals (18).

EWS were introduced to Turkey's health system in 2014 with the voluntary international accreditation standardards. Early response to changes in a patient's condition is critical to potentially preventing further deterioration. Hospitals that develop a systematic approach to early recognition and intervention of patients whose condition is deteriorating may reduce cardiopulmonary arrests and patient mortality (32,33). Moon and colleagues (33) studied two hospitals and found that deaths per adult admission decreased from 1.4 to 1.2% in one hospital and from 1.5 to 1.3% in the other.

The aim of this study is to recommend models for early warning scores that would allow early detection of physiological changes in hospitalized adult and pediatric patients. This system is not yet widely used in Turkey and not included in national health quality standards.

MATERIAL AND METHOD

A literature review of the early warning system was conducted and evidence-based validated studies were examined for adult and pediatric patients. Then expert opinions were solicited about the app-

Table 1. Adult Patient Early Warning Assessment and Monitoring Form

ADULT PATIENT EARLY WARNING ASSESSMENT AND MONITORING FORM

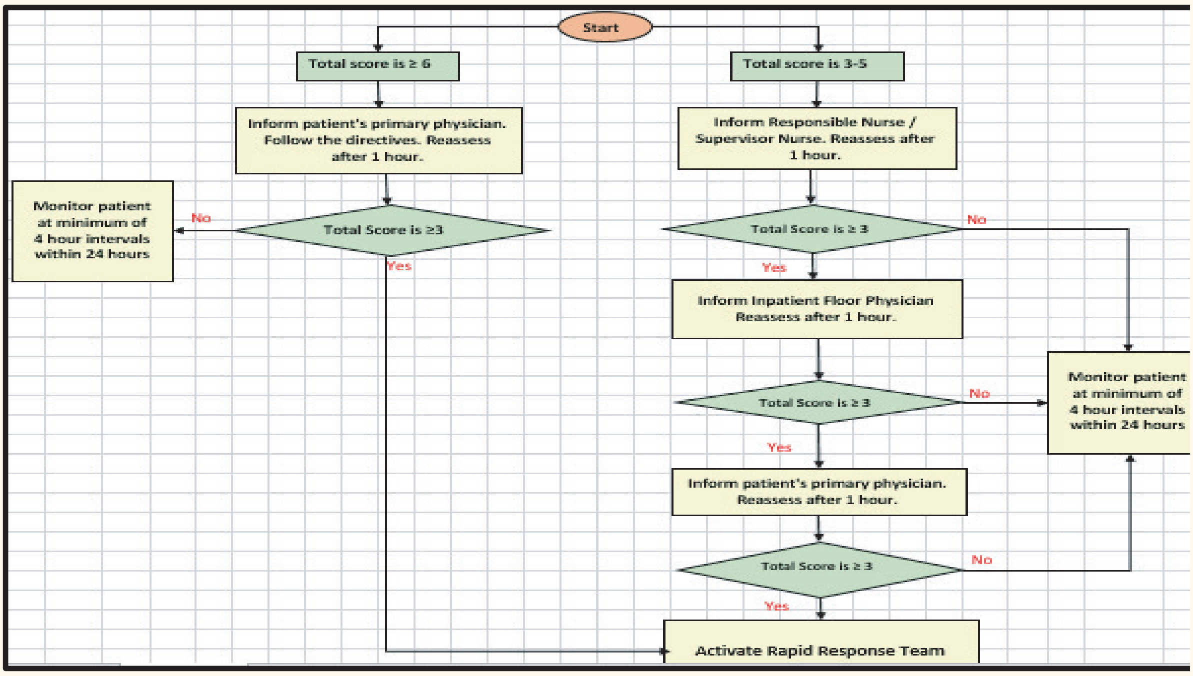
PATIENT LABEL

□ Code Blue Given **Code Blue Date:** ..../......../.......... **Code Blue Time:** ....:........

Reasons for Assessment: A: New Admission **B:** Transfer Between Departments **C:** Changes in Patient's General Condition **D:** Early Warning Total Score is ≥3

DATE	TIME	REASON FOR ASSESSMENT	HEART RATE						SYSTOLIC BLOOD PRESSURE					RESPIRATION RATE					BODY TEMPERATURE					STATE OF CONSCIOUSNESS				TOTAL SCORE	NURSE	
			2	1	0	1	2	3	3	2	1	0	2	2	0	1	2	3	2	1	0	1	2	0	1	2	3			
			<40	41-50	51-100	101-110	111-130	>130	<70	71-80	81-100	101-199	>200	<8	9-14	15-20	21-29	>30	<35	35,1-36	36,1-37,9	38-38,9	>39	Awake	Response to verbal stimuli	Response to painful muli	Unresponsive		Name Surname	Signat
			2	1	0	1	2	3	3	2	1	0	2	2	0	1	2	3	2	1	0	1	2	0	1	2	3			
			2	1	0	1	2	3	3	2	1	0	2	2	0	1	2	3	2	1	0	1	2	0	1	2	3			
			2	1	0	1	2	3	3	2	1	0	2	2	0	1	2	3	2	1	0	1	2	0	1	2	3			
			2	1	0	1	2	3	3	2	1	0	2	2	0	1	2	3	2	1	0	1	2	0	1	2	3			
			2	1	0	1	2	3	3	2	1	0	2	2	0	1	2	3	2	1	0	1	2	0	1	2	3			
			2	1	0	1	2	3	3	2	1	0	2	2	0	1	2	3	2	1	0	1	2	0	1	2	3			

* Patients are assessed during initial admission, department change and change in general condition. Used when Early Warning Total Score is ≥ 3. Assessed every hour if total sc is ≥ 3. Used for inpatients except Intensive Care Units and Emergency Service.



licability of these models to the Turkish healthcare system.

Ethics: Institution approval was received.

FINDINGS

An algorithm was recommended for adult patients that includes heart rate, blood pressure, respiratory rate, body temperature, state of consciousness parameters, reference intervals and medical interventions given to the patient (**Table 1**). These model patients are assessed during initial admission, department change and change in general condition. It has been applied to all adult inpatients except for those in intensive care units and emergency services.

For pediatric patients, an algorithm was recommended including respiratory, circulatory and behavioral / neurological system parameters, reference intervals, and medical interventions given to the patient. An extra 2 points are given if there is a need for a nebulizer every 15 minutes or if there is persistant vomiting after surgery. Patients are assessed during initial admission, department change, and change in general condition (**Table 2**).

Table 2. Pediatric Patient Early Warning Assessment and Monitoring Form

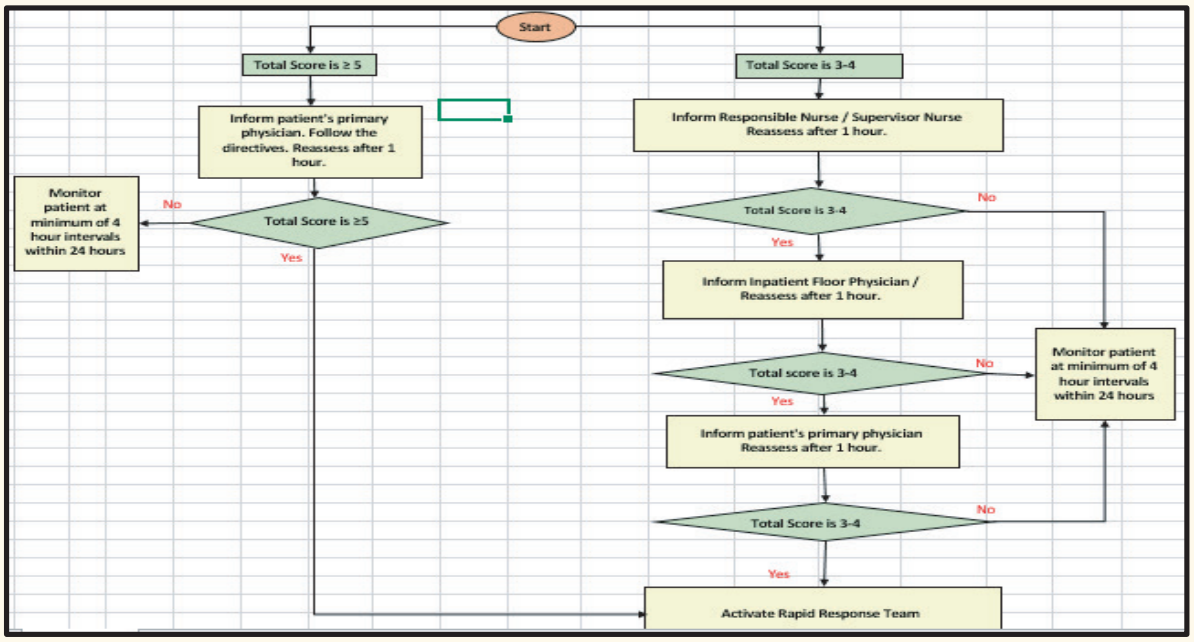
PEDIATRIC PATIENT EARLY WARNING ASSESSMENT AND MONITORING FORM | PATIENT LABEL

☐ Code Blue Given | Code Blue Date: ...../...../..... | Code Blue Time: .....

Reasons for Assessment: | A: New Admission | B: Transfer Between Departments | C: Changes in Patient's General Condition | D: Early Warning Total Score ≥3

DATE	TIME	REASON FOR ASSESSMENT	BEHAVIORAL / NEUROLOGIC				CARDIOVASCULAR				RESPIRATION				TOTAL SCORE	Nurse	
			0	1	2	3	0	1	2	3	0	1	2	3		Name Surname	Signature
			Playing / Awake	Sleeping / Response to verbal stimuli	Response to irritable painful stimuli	Lethargic / confused No response to painful stimuli	Capillary refill time 1-2 sec	Capillary refill time 3 sec	Capillary refill time 4 sec	Capillary refill time ≥ 5 sec	Normal limits / No retraction SpO2 ≥92% in room temperature	Respiration rate is above 10 from the normal limits / Using accessory muscles / FiO2 30% or 3 L/min	Respiration rate is above 20 from the normal limits / Retraction is present/ FiO2 40% or 6 L/min	Respiration rate is below 5 from the normal limits, along with retraction or groaning / FiO2 50% or 8 L/min			
			0	1	2	3	0	1	2	3	0	1	2	3			
			0	1	2	3	0	1	2	3	0	1	2	3			
			0	1	2	3	0	1	2	3	0	1	2	3			
			0	1	2	3	0	1	2	3	0	1	2	3			
			0	1	2	3	0	1	2	3	0	1	2	3			

** An extra 2 points will be given if there is a need for nebulizer every 15 minutes or if there is persistant vomiting after surgery.
** Patients are assessed during initial admission, department change and change in general condition. Used when Pediatric Early Warning Total Score is ≥ 3. Assessed every hour if total score is ≥ 3. Used for inpatients except Intensive Care Units and Emergency Service.



DISCUSSION

The prevention of cardiopulmonary arrest is a fundamental element of patient safety (34). For many countries, cardiac arrest survival rates in hospitals have emerged as a potential performance measure. Main purpose of clinicians and policymakers is to reduce the mortality rate from inhospital cardiac arrest (35).

A tool for early identification of patients at risk of worsening clinical condition is critical to prevent the occurrence of serious adverse events. The development of EWSs to help hospital staff identify patient physiological deterioration began in the late 1990s (12). The main goal for EWS is a rapid clinical response to the patient's newly identified needs with demonstrable improvements in both the processes of care and clinical patient outcomes (36). In a study in Australia, Leuvan and Mitchell (37) found that blood pressure, heart rate, and body temperature were the most rigorously recorded vital signs, whereas records of respiratory rate were poor. Respiratory rate and heart rate, has been identified as being the most sensitive and earliest indicator of a patient's deterioration in condition (38,39). There have been significant improvements in patient outcomes such

as a decrease in unplanned intensive care admission and a decrease inhospital mortality with the use of early warning systems that provide close monitoring of patients vital signs. (7). A minimum of 4.5% and a maximum of 41% ICU admissions were potentially avoidable (40). Studies have shown that in 30% to 60% of cases death, cardiac arrest and intensive care unit admission, physiological parameters of the patients were deteriorated 24 hours before arrest (41,42). Green and Williams (43) have found that after implementing EWSs the proportion of clinically unstable patients (who were on the ward for 6 hours or longer) had decreased admitted to the ICU from 41.2% to 24.5%. A study showed significant percentage of patients had increased MEWS values, even 20 hours before ICU admission and ICU length of stay is related to MEWS values measured even 8 hours before ICU admission. The ICU mortality rate and the ICU length of stay are used as strong indicators not only for ICU but also for hospital quality of care (44). Many studies have highlighted to EWSs in reducing the incidence of cardiac arrests, the proportion of ICU patient admissions and patient mortality (33,45). Johnson and Nileswar (46) found a statistically significant increase in survival at hospital discharge after the implementation of MEWS in a tertiary hospital. Therefore, the majority of cardiac arrest in hospitals can be prevented (47).

In addition, when early warning systems are used in conjunction with an Medical Emergency Team (MET) in hospital, patients who require special attention can be evaluated earlier and adverse events can be reduced (10). The MET consisting of health professionals can help them to respond more effectively to patients with severe clinical deterioration. METs are different from other code teams because the aim of these teams is to detect early deterioration of the patients' clinical condition before cardiopulmonary arrest and to take the necessary intervention (48). The risk of patient deterioration in hospital environment may not be easily identified. So it is useful to have an evaluation system that can be used by health professionals with different training and experience (49). In 1995, Lee et al.(50) introduced a MET in Australia to early detection of patients at risk for cardiac arrest. Goldhill et al. (16) formed such a team to significantly reduce cardiopulmonary arrests from 30.4% to 3.6%. Some studies performed an analysis of MET efficacy and reported that the number of cases of unexpected cardiac arrest decreased by 50% (29,51) and that the mortality rate decreased from 77% to 55% (29). In Japan, Taniguchi (29) introduced the rapid response system (RRS) and MET in 2014. Rapid response team (RRT) is one approach to addressing the issue of staff being unaware of signs of inhospital patients being at risk of imminent critical illness (6). RRTs aim to intervene before heart and respiratory arrest occur in patients with signs of deterioration during hospitalization. Rapid response system implementation was associated with reductions in cardiopulmonary arrests outside of the intensive care unit and reduced mortality (52,53). Chan and colleague (54) found that after rapid response team implementation, mean hospital-wide code rates decreased from 11.2 to 7.5 per 1000 admissions. Institute for Healthcare Improvement identified rapid response systems as a core tool to reduced mortality and reduce preventable loss of life (55). Several studies showed an improvement in patients' clinical outcomes after the introduction of EWSs, it is difficult to draw a general conclusion due to the lack of use of a single standardized score and the use of different populations (56). The adaptation of new systems into healthcare organisations is not easy; Etherington (57) emphasized the need for a holistic system approach to adapt the early warning system to the hospital and that all professional groups should be owned to ensure that the system work in their hospitals.

In a study conducted in our country, the use of early warning score system was found to be effective in early detection and intervention of complications (58). Çetinkaya et al. found that the modified early warning with rapid lactate level scoring system is effective in determining the mortality of 65 years and older patients (59). The studies about early warning system in our country are mostly aimed at informing and raising awareness so research studies are needed (60-62).

EWSs used in paper-based systems in historical process and simple algorithms are used due to the difficulty of scoring. Nowadays, digital systems are used to record vital signs of patients and calculate EWSs, offering the opportunity to be more rigorous and innovative in the development and implementation of new EWSs (2). Physicians and other health care professionals have been hopeful that computerized EWSs would aid in identifying patients at risk of clinical deterioration prior to bedside recognition by clinicians (36). Some studies have suggested an association between use of electronic systems and reduced in hospital mortality (63).

CONCLUSION

Since reduction of in-hospital mortality is a universal priority, implementation of an EWSs can be an effective step towards achieving this target. Many arrests in hospitals can be alerted early by the warning signs, with early intervention to promote better outcomes. According to the early warning scores, early intervention reduces the cardiac arrest, unnecessary intensive care admission, length of hospital

stay, and provides cost advantage. It's important for hospital administrators to give importance to this issue and to set up similar systems in hospitals. Studies have shown that artificial intelligence-based computer systems are more effective in this regard. In our country, further studies are needed on this subject, and efforts to assess their effectiveness more accurately will be needed since the use of it becomes more widespread.

DECLARATION OF CONFLICTING INTERESTS

The author declared no conflicts of interest with respect to the authorship and/or publication of this article.

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