

# Research Paper: A Model for Predicting Hospitalized Children Appropriate for Early Discharge During Disasters



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## ABSTRACT

**Background:** Early Discharge is one of the most well-known strategies to increase hospital capacity during disasters, which is applicable by recognizing the patients appropriate for early discharge. Therefore, the current study was conducted to estimate a model for predicting hospitalized children appropriate for early discharge during disasters based on the attending physician's opinion.

**Materials and Methods:** This cross-sectional study was conducted on 210 pediatric patients hospitalized in the emergency and pediatrics wards of the hospitals covered by Mashhad University of Medical Sciences. A researcher-made questionnaire was used to collect data. Questionnaires were completed at the patient's bedside by a trained questioner. The logistic regression was used to analyze the data.

**Results:** Five variables, such as consciousness level (OR=4.677), dehydration status (2.596), ability to take milk/swallow (OR=1.930), blood oxygen saturation level (OR=1.186), and body temperature (OR=0.530) were determined as predictors for children appropriate for early discharge during disasters. The area under the ROC curve was calculated 0.848, which indicated a good curve fit of the estimated model.

**Conclusion:** The model presented in the current study can help clinical staff identify hospitalized children appropriate for early discharge during disasters.

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## 1. Introduction

The proper response of health systems to disasters depends on provided healthcare services required by an increasing number of casualties rushing to the hospitals during disasters [1-3]. As hospitals in under-developed or developing countries are not capable of meeting healthcare demands in normal conditions, they definitely face serious challenges during disasters [4-6]. Early discharge or reverse triage is one of the best strategies to solve this challenge and increase the capacity of the hospitals during disasters [7-10]. However, the key issue in applying this strategy is recognizing patients appropriate for early discharge. In other words, those whose discharge from the hospital will not endanger their health for at least 72 h [11, 12].

Children are always affected by disasters and are one of the most vulnerable groups [13]. They have their own specific demands during disasters, which needs specific plans and approaches and are very different from those of adults [14, 15]. Nevertheless, the children's needs and special conditions are usually ignored; for example, early discharge during disasters is frequently occurred in this age group [16]. Despite the significance of this issue, few studies have been conducted on identifying children appropriate for early discharge during disasters. Therefore, no tools or models to identify such children were found.

Kelen et al. offered a 5-level classification for the risk level of health-threatening events caused by early discharge of a pediatric patient [17]. However, they did not present any criterion, indicator or variable to consider a child in any class. In fact, this study only calculated and classified the acceptable risk level of the early discharge of pediatric patients, approved by a group of pediatricians.

In normal conditions, the attending physician is best person to decide about the discharge of a patient. He/she can make the best decision about the early discharge of their patients based on a range of clinical and non-clinical variables during disasters [18]. In other words, consulting the attending physician is one of the ways to recognize patients appropriate for early discharge. However, finding an attending physician could be restricted in disasters.

Therefore, regarding the knowledge gap in this area, and also the significance of early discharge as an effective strategy to increase hospital capacity, the current study aimed at estimating a model for predicting pediatric patients appropriate for early discharge, based on the attending physician's opinion. This model not only assist the

hospital clinical staff to discharge patients during disasters in the absence of the attending physician but also can be used as a tool to assess the capability of an early discharge during normal conditions to plan for the hospital surge capacity and improve hospital disaster preparedness.

## 2. Materials and Methods

This cross-sectional study was conducted on 210 pediatric patients (younger than 14 years) hospitalized in the emergency and pediatrics wards of Imam Reza, Ghaem, Shahid Hasheminejad, and Doctor Sheikh hospitals covered by Mashhad University of Medical Sciences (MUMS). Sampling was conducted through census method because the sampling could not be achieved in the studied hospitals in one day. It was started at the time of data collection until the required subjects were achieved (three days of three weeks). The exclusion criterion was the due date of discharge at data collection day.

A trained clinician visited the hospitals and asked the patient's attending physician to fill the first part of the questionnaire. Subsequently, he filled the second part of the questionnaire after obtaining consent from the patient's parents.

Data collection was done through a researcher-made questionnaire. After conducting an extensive literature review, the research team developed the initial questionnaire, which consisted of 29 questions in two parts. Content Validity Ratio (CVR) was used to assess the validity of the initial questionnaire. Accordingly, a group of experts including 20 pediatricians was asked for their opinion about 29 questions. The calculated CVRs are presented in Table 1. The validity of 10 out of the 28 questions of the second part, and the only question of the first part were approved (Table 1). As the patient's conditions and consequently, the physician's opinion could change at any moment, the reliability was not considered.

Therefore, the final questionnaire consisted of two parts. The second part consisted of 10 questions (to measure the independent variables), whereas the first part included one question to assess the dependent variable. In this stage, the first early discharge during disasters was defined briefly, and then the patient's attending physician was provided with a short scenario about a disaster taking place near the studied hospital along with some assumptions. Based on the presented scenario and assumptions, the patient's attending physician was asked to give his opinion on the early discharge or not for his/her patient in the form of a yes/no question.

Data analysis was done by STATA v14.1. To investigate the relationship between each independent variable and the dependent variable, the Chi-squared test was used for qualitative independent variables and the T-test was employed for quantitative independent variables. Subsequently, variables with a P-value of less than or equal to 0.2 ( $P \leq 0.2$ ) entered the final logistic regression model.

### 3. Results

The results of validity of the initial questionnaire (the calculated CVRs) are presented in Table 1. As shown in Table 1, 11 questions (38%) of the initial questionnaire were approved by the experts. Regarding gender, 107 cases (51.7%) were male and 100 cases (48.3%) were female with an average age of  $4.42 \pm 3.77$  years. According to the attending physicians' opinions, 56.5% ( $n=117$ ) of the patients were appropriate for an early discharge.

Table 2 indicates the results of the Pearson chi-squared test and t-test conducted to assess the relationship between each independent variables and the dependent variable of the study (early discharge). Table 2 indicates that there was a significant relationship between the five independent variables, such as consciousness level, dehydration status, ability to take milk/swallow, blood oxygen saturation level, and body temperature and the dependent variable ( $P \leq 0.05$ ). The effect of these variables and also the pulse rate were calculated simultaneously using the logistic regression method. The estimated model and its coefficients are represented in Table 3.

As shown in Table 3, all variables with a significant relationship with early discharge. Only pulse rate showed no

significant effect on the dependent variable in this regression model. Based on the Table 3, for each unit increase in the oxygen saturation level, the chance of early discharge of the pediatric patient by the attending physician increased by 1.186%, whereas it decreased by .530% with each unit increase in the body temperature. The Table 3 indicates that the chance of early discharge was 4.677 times higher in conscious patients compared with the other patients and 2.596 higher in patients with no dehydration than those with certain degrees of dehydration. The chance of early discharge in children who had the ability to take milk/swallow was almost twice as much as those with inability to take milk/swallow (1.930 times higher).

Diagram 1 represents the ROC curve to predict the estimated regression model. Diagram 1 indicates the area under the curve of .846 with a standard error of .028, which was significant ( $P$ -value  $\leq .05$ ). The area under the curve was within the 95% confidence interval of between 0.791 and 0.901. Due to the area under the curve of between 0.8 and 0.9, this model had a good curve fit.

### 4. Discussion

Five variables of oxygen saturation, body temperature, consciousness level, dehydration status, and ability to take milk/swallow were entered the estimated model and determined as the predictors for pediatric patients appropriate for early discharge. No relevant study has been conducted to provide a model to predict which pediatric patients can be considered for early discharge during disasters. However, the findings of this study can be compared with "triage" and "reverse triage" models or models evaluating the patients' conditions, specifically pediatric patients.

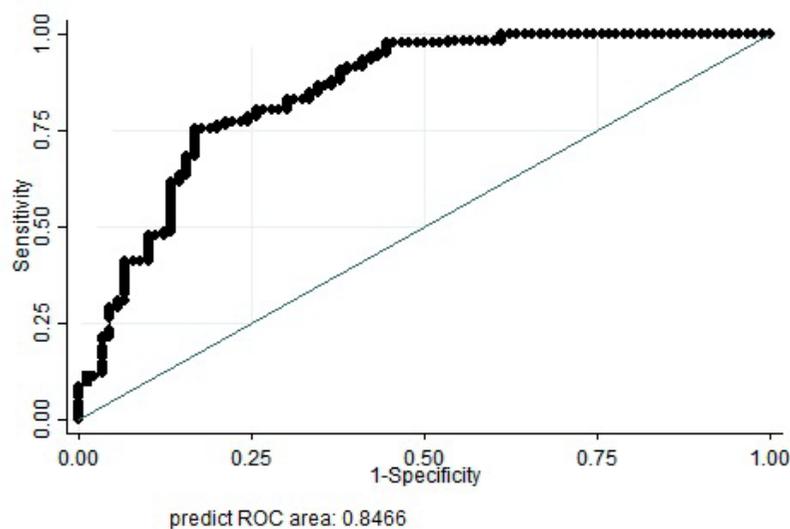


Diagram 1. The Receiver Operating Characteristic (ROC) curve of the estimated predictive model

**Table 1:** Results of the validity of the initial questionnaire (the Calculated Content Validity Ratios) or (CVRs)

Questions	Validity	
	Reject (CVR≤13)	Accept (CVR≥14)
Age	-	18
The patient’s parents education level	6	-
The household’s income	4	-
The patient’s access rate to healthcare centers	13	-
The caretaker’s relation to the patient	6	-
Blood pressure	-	15
Blood oxygen saturation	-	20
Pulse rate	-	14
Body temperature	-	18
Breathing rate	-	15
Crying type	13	-
Ability to take milk/swallow	-	17
Restlessness	12	-
Heart sounds	5	-
Lung sounds	4	-
Skin color	11	-
Dehydration status	-	20
Consciousness level	-	17
Hospitalization type (elective or emergency)	10	-
Hospitalization period	6	-
Blood sodium level	11	-
Blood potassium level	13	-
Hemoglobin level	10	-
Platelets level	6	-
Urea level	4	-
Creatinine level	7	-
Blood sugar level	-	16
Skin bilirubin level	7	-
Based on the given definition of early discharge, scenario and assumptions, will you early discharge your patients	-	18

Early discharge during disasters is also called reverse triage. Although in the early discharge, patients at good conditions are selected, in triage, those at bad health conditions are considered; it can be said that both types have almost similar factors that are related to the general conditions of the patients.

It can be concluded that the consciousness level, as the most important predictor in the current study (OR=4.67), was also the major variable and the common component in almost all of the triage and assuagement models and tools. These models can be used for evaluating pediatric patients,

such as “Pediatric South African Triage Score Chart”, “Jump START Pediatric Mass Casualty Incidents Triage” and “Pediatric Triage Tape” or assessing adults, such as “Glasgow Coma Scale”, “The Acute Physiology and Chronic Health Evaluation” and “Care Flight Triage” [19-24]. Nevertheless, the method to evaluate the consciousness level or the scoring system is varied in each model. Severe life-threatening dangers caused by disorders in the central nervous system could justify the significance and presence of consciousness level in all the available models.

**Table 2.** The relationship between independent and dependent variables (attending physician’s decision for early discharge)

Independent Variable	P
Consciousness level	0.002*
Dehydration status	0.000*
Ability to take milk/swallow	0.000*
Age	0.484
Blood pressure	0.633
Oxygen saturation	0.000*
Pulse rate	0.140*
Body temperature	0.000*
Breathing rate	0.589
Blood sugar level	0.527

\*P<0.2

**Table 3.** The estimated predictive model for early discharge of pediatric patients during disasters

Variable	Coefficient	P	Odds Ratio	95% Confidence Interval
Oxygen saturation	0.171	0.000*	1.186	1.113–1.264
Pulse rate	-0.008	0.477	0.991	0.969–1.014
Body temperature	-0.633	0.016*	0.530	0.317-0.888
Consciousness level	1.542	0.011*	4.677	1.422–15.377
Dehydration status	0.954	0.004*	2.596	1.367–4.930
Ability to take milk/swallow	0.657	0.003*	1.930	1.247–2.987

\*P-value≤.05

Although two other predictors of dehydration status and ability to take milk/swallow are less common in triage models and algorithms and also models for evaluating pediatric patients, this inconsistency could be caused by the difference in their context. Most of these models and studies have been conducted in developed countries, whereas the current study was conducted in a developing country, where some parts of total disease burden and mortality rate in children are attributed to dehydration (caused by gastrointestinal infections) and malnutrition. This challenge has been noted in the Guidelines of Integrated Healthcare for children’s Illnesses, which is considered as the national clinical guidelines for the management of ill children. Assessing the pediatric patient’s dehydration and nutrition status, such as their ability to take milk/swallow, is a part of the emergent signs’ evaluation in the mentioned guidelines [25].

Based on the findings of this research, blood oxygen saturation level is another predictor for selecting pediatric patients appropriate for early discharge during disasters, which is consistent with the “Save a Child and Pediatric Assessment Triangle” guidelines [26, 27]. In this guideline, the ventilation status is somehow an indicator of the blood oxygen saturation level. The significance of sufficient oxygen supply for the brain and also the risk of reduced brain oxygen could explain the presence of blood oxygen saturation in the current model.

Body temperature is an indicator evaluated in most methods and algorithms evaluating children’s emergencies, namely the “Revised Pediatric Emergency Assessment Tool”, “WHO’s Pediatric Emergency Triage”, and “Assessment and Treatment Guideline”. Severe complications caused by high fevers and high body temperatures,

such as convulsion can justify the presence of this variable in this model and the other models, as well [28-30].

The limitation of the current study was the used method for evaluating early discharge: 'Appropriate for early discharge' or 'inappropriate for early discharge', based on the attending physician's opinion. Theoretically, the best and most accurate method for evaluating this factor could have been discharging all pediatric patients for 72 h and checking their probable complications and severe life-threatening health consequences; however, this strategy is not applicable practically and ethically. Therefore, as mentioned in the introduction, the best alternative was using the attending physician's opinion on the early discharge by a hypothetical scenario. However, another alternative could be using real data during disasters. It is suggested to evaluate the sensitivity of this model in future studies using real data obtained from children discharged early from hospitals during a real disaster.

## 5. Conclusion

Finally, given the area under the curve of .84, the model was found at a good level and acceptable for practice to correctly identify hospitalized children for early discharge during disasters [31]. In general, the model presented in the current study can be used as a framework for developing a tool in order to recognize hospitalized children appropriate for early discharge during disasters, and consequently can increase hospital capacity during disasters.

## Ethical Considerations

### Compliance with ethical guidelines

The study was approved by the Research Ethics Committee of Mashhad University of Medical Sciences (Code: IR.MUMS.REC.1395.430).

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### Authors' contributions

All authors contributed to prepare this research.

### Conflict of interest

All authors contributed in designing, running, and writing all parts of the research.

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