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Predicting mortality in geriatric patients with fever in the emergency departments: a prospective validation study

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Abstract

Objective Emergency physicians are always faced with the challenge of choosing the appropriate disposition for elderly patients in order to ensure an acceptable care plan and effective use of resources. A clinical decision rule, Geriatric Fever Score (GFS) has been proposed but not validated to help ED physicians with decision-making. This rule employs leukocytosis, severe coma, and thrombocytopenia as predictors of 30-day mortality. Through our study determines the performance of this clinical prediction rule in a prospective study in a setting different from where it was developed.

Method and materials In this prospective cohort study in a 1200-bed tertiary care, patients older than 65 years old who visited the ED with fever were enrolled. All elements of the rule were collected and the total score was calculated for each patient. Patients were also categorized as low risk (score 0–1) or high risk (score ≥ 2). Thirty-day follow-up was performed to determine the patient outcome (survival or mortality).

Results A total of 296 patients were included in our final analysis. The mortality rate was 33.1% for patients with a Score of 0, 42.1% for a score of 1, 57.1% for a score of 2, and 100% for a score of 3. When divided into two risk groups, patients' mortality rates were as follows: low risk group 37.9% and high-risk group 40.5%.

Conclusion Our study showed that elderly patients who present to ED with fever and have a score of 2 or higher on the Geriatric Fever Score are at higher risk of mortality at 30 days.

Keywords Geriatric Fever Score, Geriatric, Mortality, Fever, Emergency department

Introduction

Although adults aged 65 and older represent about 8% of the general population, they account for approximately 28% of all emergency department (ED) visits [1]. In addition to the higher rate of ED utilization, elderly patients presenting to the ED are more likely to be hospitalized than younger patients (14.3% versus 4.7%) [2].

On the other hand, emergency admissions of elderly patients can be detrimental and bear many complications—during hospitalization or even after discharge—such as delirium, malnutrition, dehydration, infection, and falls [3]. The hospitalization of geriatric patients

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usually consumes many resources and results in higher costs. Therefore, ED physicians are always faced with the challenge of choosing the appropriate disposition for this group of patients to ensure an acceptable care plan and effective use of resources [4].

Predictors of poor outcomes in geriatric patients can be divided into two groups: factors about the vulnerability of the patient (such as multi-morbidity, cognitive dysfunction, and polypharmacy) and parameters reflecting the severity of the disease at admission time [5].

One of the most common causes of elderly ED visits is fever, comprising approximately 15% of all visits [6, 7].

Therefore, some studies have proposed decision rules based on mortality predictors to help ED physicians make optimum decisions on managing geriatric patients with fever. These include Quick Sequential Organ Failure Assessment Score, National Early Warning Score (NEWS), Dengue fever mortality Score, Mortality and bloodstream infections, and Systemic Inflammatory Response Syndrome (SIRS) Criteria [8]. None of these prediction rules are specific to the geriatric population. Besides, there are other scores for predicting mortality in elderly patients [9]. These scores are not focused on patients presenting with fever. These include the Barthel Index, Neutrophil to Lymphocyte Ratio (NLR), and Geriatric influenza death (GID) score. Moreover, these rules often employ numerous variables that are not immediately available to emergency physicians, rendering them impractical in the ED setting [10].

Geriatric Fever Score (leukocytosis, severe coma, and thrombocytopenia) was first introduced in 2014 as a practical rule for this purpose. It was originally driven in a single tertiary care center in Taiwan through a retrospective study of 330 elderly patients presenting to ED [4]. It has not been externally validated and the retrospective nature of the study might have affected its results.

Through our study determines the performance of this clinical prediction rule in a prospective study in a setting different from where it was originally developed.

Methods

Study design and setting

This prospective cohort study was conducted in a 1200-bed tertiary care, university-affiliated medical center. The center provides care for approximately 100,000 patients in the ED per year, about 33% of whom are elderly.

Study population

Non-traumatic geriatric patients (≥ 65 years old) who visited the ED between 1 June 2021 and 1 June 2022 were enrolled through a convenience sampling method. The study was approved by the ethics committee of Tehran University of Medical Sciences (IR.TUMS.IKHC.REC.1399.122). Written informed consent was obtained from all participants.

The patients were assessed for eligibility if they had a fever, defined as a tympanic temperature > 37.2 C [11]. Patients were excluded if they left the hospital against medical advice or if they had missing data making it impossible to calculate the score.

Data collection and definition of variables

Two investigators (G.H., K.N.) collected data elements of the GFS (leukocytosis, severe coma, and thrombocytopenia). The level of consciousness on admission was recorded as the Glasgow Coma Scale score. All patients had complete blood counts within two hours of admission, checked with a Sysmex cell counter device. Every mortality predictor was given one score. Patients were then classified as low risk (those who scored 0–1) or high risk (those who scored ≥ 2). Investigators also logged age, sex, and past medical history.

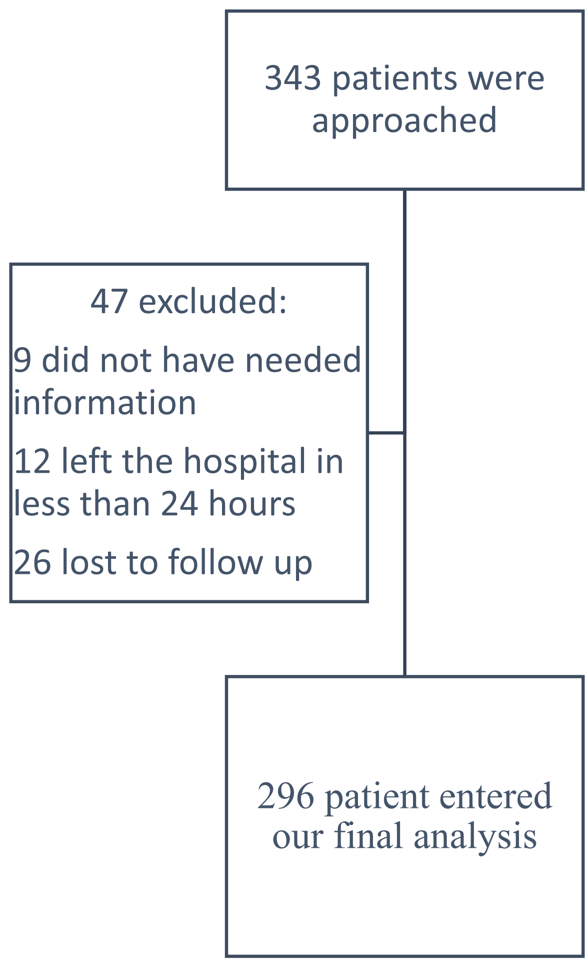

Fig. 1 Flow chart of the participants in the study

Outcome measurement

We used all-cause 30-day mortality as the primary outcome in this study. The researchers (G.H. and K.N.) checked the hospital registration system to find any readmission or in-hospital mortality of patients during the follow-up period. If the patients were discharged before 30 days telephone follow-up was used for the evaluation of outcomes. For patients who had readmission with hospital registration system evaluated 30 day-mortality.

Data analysis

Categorical variables were presented as numbers (percentages) and compared by the chi-square test. We used the area under the receiver operating characteristic curve (AUC) to assess the discrimination ability of our model (the geriatric fever score). Sensitivity, specificity, positive and negative predictive (PPV and NPV), and positive and negative likelihood ratio (+LR and −LR) values with 95% CI were reported by creating the two-by-two contingency tables. To calculate the diagnostic test performance, we used an online calculator (available at https://www.medcalc.org/calc/diagnostic_test.php). IBM SPSS Statistics for Windows, version 26 (IBM Corp., Armonk, N.Y., USA) was used for all statistical analysis. For sample size calculation, considering the area under the ROC curve for the Geriatric Fever Score of 0.73 as presented in the original study, with an alpha of 0.05 and power of 80%, we needed 358 patients to show the effect size of 0.12. While a *p*-value of less than 0.05 was considered significant to avert the

Table 1 Demographic and baseline clinical characteristics of the patients

		All; *N* = 296 Number (%)	Survived (N: 176) Number (%)	Dead (N: 120) Number (%)	*P* value*
Age (years)	65–75	148 (50)	103(58.5)	45(37.5)	0.0004
	> 75	148 (50)	73(41.5)	75(62.5)	
Gender	Male	164 (55.4)	100 (56.8)	64 (53.3)	0.55
	Female	132(44.6)	76(43.2)	56(46.7)	
Past Medical History					
Hypertension		144 (48.6)	92 (52.3)	52 (43.3)	0.13
Diabetes		94 (31.8)	55 (31.3)	39 (32.5)	0.82
Coronary artery disease		55 (18.6)	41 (23.3)	14 (11.7)	0.012
Congestive heart failure		13 (4.4)	10 (5.7)	3(2.5)	0.19
Cerebrovascular accident		30 (10.1)	17 (9.7)	13 (10.8)	0.74
Hyperlipidemia		42 (14.2)	24 (13.6)	18 (15)	0.74
COPD		25 (8.4)	19 (10.8)	6 (5)	0.08
Cancer		43 (14.5)	16 (9.1)	27 (22.5)	0.001
Liver disease		8 (2.7)	5 (2.8)	3 (2.5)	0.86

COPD Chronic obstructive pulmonary disease, *: with Bonferroni correction, *P* value < 0.001 is considered significant

Table 2 Study variables and total scores as predictors for 30-day mortality

Study Variable		Survived Number (%) N:176	Died Number (%) N: 120
GCS	< 8	9 (5.1%)	16 (13.3%)
	≥ 8	167 (94.9%)	104 (86.7%)
WBC	< 12000cells/mm3	121 (68.8%)	66 (55%)
	> 12000cells/mm3	66 (55%)	54 (45%)
PLT	< 150,000/mm3	43 (24.4%)	34 (28.3%)
	> 150,000/mm3	132 (75%)	84 (70%)
Total score	0	81 (46.0%)	40 (33.3%)
	1	83 (42.2%)	60 (66.7%)
	2	12 (6.8%)	16 (13.3%)
	3	0 (0%)	4 (3.33%)

GCS Glasgow Coma Scale, *WBC* White Blood Cell, *PLT* Platelet risk of multiplicity, we used Bonferroni correction of the *P*-value to less than 0.001 for characteristic table test results using Chi-Square tests.

Results

We enrolled 343 patients during the study period. Nine patients were excluded because of insufficient data and 12 patients for leaving the hospital before 24 h. In addition, 26 patients were lost to follow up. Therefore, a total of 296 patients were entered into our final analysis. (Fig. 1) Half of the patient were above 75 years old. The baseline demographics and clinical characteristics of the patients are summarized in Table 1.

The mortality rate was 33.1% for patients with a Score of 0, 42.1% for a score of 1, 57.1% for a score of 2, and 100% for a score of 3. When divided into two risk groups, patients' mortality rates were as follows: low risk group 37.9% and high-risk group 40.5% (Table 2).

The area under the ROC curve for the Geriatric Fever Score was 0.59 (95% CI: 0.52 -0.65), with statistically significant discrimination ability ($p=0.01$) (Fig. 2).

The diagnostic performance of the GFS has been shown in Table 3.

Discussion

In this study, we tried to validate the GFS in predicting 30-day mortality of elderly patients who present to the ED with fever. The findings of our study showed that a GFS of ≤ 1 could predict with an acceptable sensitivity of 95% that the patient will have a 30-day survival. This can help emergency physicians in deciding to transfer patients to a general ward or discharge with close follow-up after treatment in the ED. According to a systematic review, qSOFA showed a lower sensitivity (56.39%) but a higher specificity (78.84%), whereas SIRS showed a higher sensitivity (74.58%) but a lower specificity (35.24%) for hospital and 30-day mortality in sepsis. These rules are the most practical rules for sepsis mortality but they are not specific for the geriatric group [12].

Geriatric patients presenting with an infection may have atypical symptoms, such as a decline in functional physical status or altered mental status, or both [1]. Several other studies have pointed to cognitive impairment as an important predictor of in- and out-of-hospital geriatric all-cause mortality [4]. According to Chung et al. study, severe coma was a stronger predictor than thrombocytopenia and leukocytosis in GFS [4].

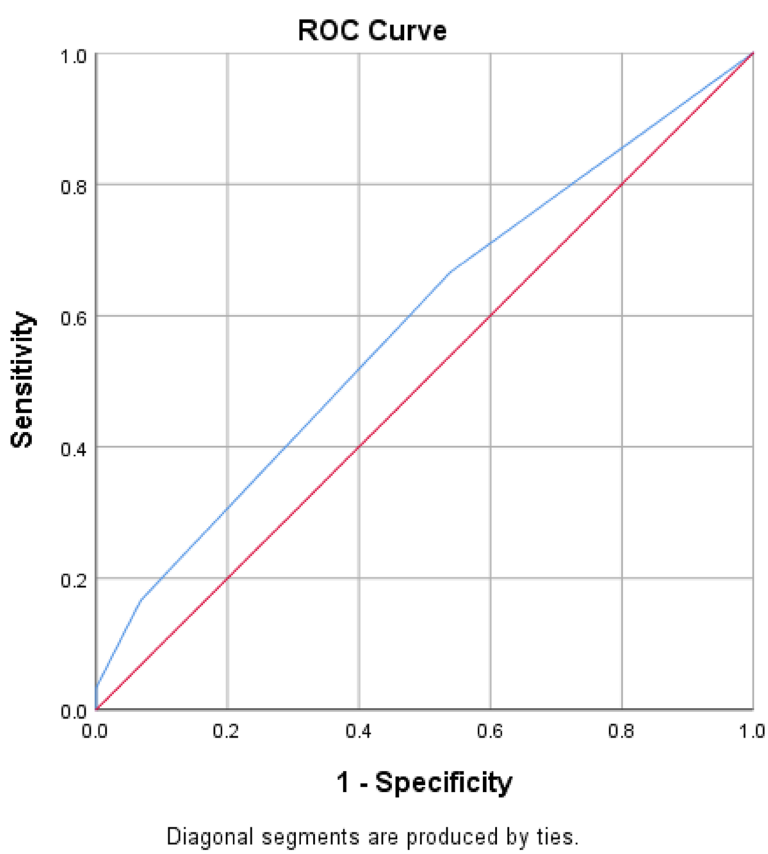

Fig. 2 Receiver operating characteristic Curve for GFS. Area under the curve (AUC): 0.59 (95% CI: 0.52 -0.65)

Table 3 The diagnostic performance of the GFS

Scale score		True positive	False positive	False negative	True negative	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)	Positive Likelihood Ratio (95% CI)	Negative Likelihood Ratio (95% CI)	Patients stratified as low risk (%)
GFS	≥1	80	95	40	81	66.67% (57.48% - 75.01%)	46.02% (38.50% - 53.68%)	45.71% (41.15% - 50.36%)	66.94% (60.02% - 73.20%)	1.24 (1.03 - 1.49)	0.72 (0.54 - 0.98)	121 (40.88%)
	≥2	20	12	100	164	16.67% (10.49% - 24.56%)	93.18% (88.39% - 96.43%)	62.50% (45.85% - 76.64%)	62.12% (59.99% - 64.20%)	2.44 (1.24 - 4.81)	0.89 (0.82 - 0.98)	264 (81.19%)

However, recognition of altered cognitive status is difficult, as it must be compared with the baseline mental status of each patient. In our study, according to Chung et al. study, severe coma, defined as GCS ≤ 8) was used instead of altered cognitive status. We believe that this parameter is accurate and more practicable in clinical practice.

In a large-scale prospective analysis, Duan et al. explored the association of cognitive impairment and increased risk of all-cause mortality. This analysis was based on two Chinese cohorts with a 6-year follow-up period [13]. According to the study of Fogg et al., the highest in-hospital mortality (12.6%) was in patients with cognitive impairment [14]. The population in our study was similar to this study; about 13.3% of febrile geriatric patients with severe coma died.

In another study, Yao et al. showed impaired cognition had a higher risk of non-elective hospital readmission or death in geriatric patients (Hazard Ratio: 2.50, 95% CI: 1.27–4.91, $P=0.008$) [15]. Morandi et al., in a study on a large cohort of medical and surgical older inpatients from 205 acute hospital wards in Italy, found that delirium and delirium superimposed on dementia had significant associations with increased risk of in-hospital death [16].

Leukocytosis was the second strongest predictor of mortality in GFS. Chung et al. found (59.1%) of all patients with leukocytosis had 30-day mortality. In our study, 45% of patients who died within 30 days had leukocytosis. Fernandez-Garrido et al. found WBC counts as a predictor of hospitalization and death [17]. The study of Asadollahi et al. showed that leukocytosis (WBC > 10 × 109/L) was significantly associated with in-hospital mortality (OR 2.0, $p < 0.001$) [18].

While many studies have explored the relationship between leukocytosis and all-cause mortality, some studies have pertained to different definitions of leukocytosis. Marco et al. studied geriatric patients with fever who presented to the ED and found that leukocytosis (defined as a WBC count of 11,000 cells/mm3 or more) is a predictor of serious illness. Wasserman et al. found increasing specificity but decreasing sensitivity with increasing the cut-off for leukocyte counts from 11,000 to 14,000 or 16,000/mm3 [19].

Thrombocytopenia, defined as platelets < 150,000 / mm3, was also a predictor of mortality in our study. We think that a threshold of < 150,000 /mm^3 is easier to remember than platelets < 100,000 /mm^3, which is used in the Surviving Sepsis Campaign Guidelines 2012. Çakir et al. evaluated the relationship between mortality and erythrocyte and platelet indices in geriatric patients with sepsis. They found that low platelet count was a significant indicator of mortality. The average platelet count of non-survived patients in this study was 176.0 ± 83.7 [20]. The study of Misirlioğlu et al. showed that although 30-day mortality was more frequent in patients with thrombocytopenia at presentation, there was not a statistically significant difference. This is likely due to the low number of thrombocytopenic patients [21].

Limitations

Our study had several limitations. First, we employed a convenience rather than a consecutive sampling method. However, random shifts of researchers would compensate for this shortcoming to some extent. Second, our study was conducted in a single tertiary care referral hospital. The findings from our study might not be generalizable to other populations. Third, the calculation of GCS was performed by one person, and not rechecked by another physician. Moreover, GCS may not be reliable in patients with non-traumatic cognitive impairments. Determination of the effective sample size is crucial and our sample size is close to what was calculated as the required sample size, according to our statistical analysis. However, another study in the much larger data set can be helpful.

Conclusion

Our study showed that elderly patients who present to ED with fever and have a score of 2 or higher on GFS are at higher risk of mortality within 30 days.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12877-024-05346-x.

Supplementary Material 1

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Authors' contributions

H.A. and A.A. wrote the manuscript. A.S. and H.M. statistical analysis and methodologist. M.J. consultant. H.A. had the idea and supervised the study. H.G. collected data.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Data availability

Data is provided within the manuscript or supplementary information files.

Declarations

Ethics approval and consent to participate

The study was approved by the Tehran University of Medical Science Ethical Committee (IR.TUMS.IKHC.REC.1399.122). Written informed consent was obtained from all participants.

Further information and documentation to support this is available to the Editor on request.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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