Experimental Gerontology 175 (2023) 112136

Contents lists available at ScienceDirect

Experimental Gerontology

journal homepage: www.elsevier.com/locate/expgero

Validity of the Korean triage and acuity scale in older patients compared to the adult group

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ARTICLE INFO

Section Editor: Christiaan Leeuwenburgh

Keywords:
Triage
Emergency department
Aged
Geriatrics

ABSTRACT

Introduction: While many patients visit the emergency department (ED) for various reasons, medical resources are limited. Therefore, various triage scale systems have been used to predict patient urgency and severity. South Korea has developed and used the Korean Triage and Accuracy Scale (KTAS) based on the Canadian classification tool. As the elderly population increases, the number of elderly patients visiting the ED also increases. However, in KTAS, there is no consideration for the elderly, and the same classification system as adults. The aim of this study is to verify the ability of KTAS to predict severity levels in the elderly group, compared to the adult group.

Methods: This is a retrospective study for patients who visited the ED at two centers between February 1, 2018 and January 31, 2021. The initial KTAS level, changed level at ED discharge, general patient character, ED treatment results, in-hospital mortality, and lengths of hospital and ED stays were acquired. Area under the receiver operating characteristics (AUROC) was used to verify the severity prediction ability of the elderly group to KTAS, and logistic regression analysis was used for the prediction up-triage of KTAS.

Results: The enrolled patients in the study were 87,220 in the adult group and 37,627 in the elderly group. The proportion of KTAS up-triage was higher in the elderly group (1.9 % vs. 1.2 %, $p < 0.001$). The AUROC for the overall admission rate was 0.686, 0.667 in the adult and elderly group, the AUROC for ICU admission was 0.842, 0.767, and the AUROC for in-hospital mortality prediction was 0.809, 0.711, indicating a decrease in the AUROC value in the elderly group. The independent factors of the up-triage predictors were old age, male gender, pulse, and ED length of stay, and old age was the most influential variable.

Conclusion: KTAS was poorly associated with severity in the elderly than in adults, and it was found that up-triaging was more likely to occur in the elderly. The severity and urgency of patients over 65 years of age should not be underestimated when initially determining the triage scale.

1. Introduction

Globally, the aging population is expected to increase to 1.4 billion by 2030 and 2.1 billion by 2050. Aging society means when the proportion of the population aged 65 or older is >7 %. In South Korea, the proportion of the population aged 65 or older was recorded 7.2 % in 2000 and is increasing rapidly to 10.8 % in 2010 and 15.7 % in 2020 (Service, K.S.I., 2021). With the rapid aging of the population, the demand for medical services for elderly patients is increasing (Mirel and Carper, 2001). Older patients tend to visit the emergency department (ED) more often, stay longer, and are more urgent than adult patients because they have many underlying diseases and atypical symptoms,

Abbreviations: ED, Emergency department; CTAS, Canadian Emergency Department Triage and Accuracy Scale; ATS, Australian Triage Scale; ESI, Emergency Severity Index; MTS, Manchester Triage Scale; JTAS, Japan Triage and Accuracy Scale; TTAS, Taiwan Triage and Accuracy Scale; KTAS, Korean Triage and Accuracy Scale; NEDIS, National Emergency Department Information System; DOA, Dead on arrival; SBP, Systolic blood pressure; DBP, Diastolic blood pressure; PR, Pulse rate; RR, Respiratory rate; BT, Body temperature; LOS, Length of stay; AUROC, Area under the receiver operating characteristics; SD, Standard deviation; IQR, Interquartile range.

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https://doi.org/10.1016/j.exger.2023.112136
Received 5 January 2023; Received in revised form 25 February 2023; Accepted 2 March 2023
Available online 9 March 2023

such as masking fever due to a low temperature threshold (Janssens and Krause, 2004; Metlay et al., 1997; Salvi et al., 2007). In addition, according to some previous literature, the elderly often complained of non-specific symptoms as chief complaint when visiting the ED, which had a poor effect on the prognosis (Kemp et al., 2020; Wachelder et al., 2017).

The overcrowding of ED over the past decades is has been described as the cause of the difficulty in providing adequate emergency care worldwide (Fatovich, 2002). As the elderly population increases, frequent visits to the ED of elderly patients contribute to the ED overcrowding. When ED is overcrowded, screening patients who need critical treatment is important to prioritize treatment, due to limited medical resources (Moon et al., 2019). There are various tools around the world to assess the severity and urgency of patients. The Canadian Emergency Department Triage and Accuracy Scale (CTAS), Australian Triage Scale (ATS), Emergency Severity Index (ESI), and MTS (Manchester Triage Scale), based on the five-step classification, have greatly influenced the current severity classification scheme. Based on CTAS, Japan Triage and Accuracy Scale (JTAS) is being used in Japan, and Taiwan Triage and Accuracy Scale (TTAS) is being used in Taiwan. South Korea also developed the Korean Triage and Accuracy Scale (KTAS) in 2012 based on the Canadian classification tool and has been using it in the ED since January 2016 (Choi et al., 2019). It categorized patients from 1 to 5 according to a scale of severity, 1 being the most serious.

Miss-triage including under-triage and over-triage are known to related to increased morbidity and mortality (Najafi et al., 2019). If the patient's severity is misidentified and under-triage occurs, treatment of emergency patients may be delayed, and if over-triage occurs, efficient management of ED resources becomes difficult (Lee et al., 2019). Existing evidence suggests the elderly patients medical condition may not recognize and are more likely to under-triaged (Lamantia et al., 2013). We thought that in the case of the elderly, miss-triage would have occurred more because of they have difficulty in expressing symptoms vaguely or expressing accurate symptoms. Furthermore, under-triage results in a delay of appropriate treatment, which can increase the short-term mortality (Salvi et al., 2007). However, in the current KTAS classification, there is no consider for the elderly, and the elderly are classified through the same classification system as adults. This problem was also presented in other triage systems. Previously, some studies on the appropriateness of severity classification tools in the aged population have been conducted. In the study of JTAS, the performance of predicting hospitalization was measured lower in the elderly than in adults (Kuriyama et al., 2019). According to Brouns et al., MTS was not as effective in predicting in-hospital mortality in older patients (Brouns et al., 2019; Zachariasse et al., 2017). Furthermore, 23 % of elderly patients with immediate life-threatening events were triaged as moderate acuity (level 3) in ESI (Hinson et al., 2019). However, as far as we know, no research has been conducted to evaluate the adequacy of KTAS in elderly patients. The importance of accurate classification of elderly patients in ED is increasing in this era of aging progress and overcrowding worsening. In this study, we would like to find out whether it is appropriate to apply the KTAS classification system currently, by comparing the under-triage rate in adult and elderly group.

2. Method

2.1. Study design and population

This is a retrospective analysis of prospectively collected clinical data at the ED of two center. Each are academic tertiary hospitals located in the capital of South Korea. Including the two centers, about 60,000 patients visit the ED every year. The registry data of the National Emergency Department Information System (NEDIS), managed by the National Emergency Medical Centre and the electronic medical records (EMR) of each hospital were used. NEDIS is a prospective database of the demographic and baseline clinical characteristics of patients from all emergency healthcare facilities. We included all patients who visited these two EDs between 1 February 2018 to 31 January 2021. Patients with age under 18 years old, ED visited due to injury, had insufficient data because transferred to another hospital or discharged against medical advice, ED visited not for treatment or with unknown reasons, and dead on arrival (DOA) was excluded. The enrolled patients were divided into two groups. The patients with aged between 18 and 64 was named as “adult group”, and the patients with aged over 65 was named as “elderly group”. This study was approved by the Institutional Review Board of each hospital. Due to the study's retrospective nature and the use of anonymized patient data, the requirement for informed consent was waived.

2.2. KTAS classification

The KTAS classification is only possible by certain qualified people. Doctors, nurses, and the level 1 emergency medical technicians who have worked in the ED for at least 12 months within the past five years will be eligible for KTAS classification for the next three years if they pass the test after receiving training for a certain amount of time. This qualification provided by The Korean Society of Emergency Medicine (Kim et al., 2022). In both ED, triage was conducted by classification nurses who had clinical experience of ED more than one year with KTAS license.

When patients initial presenting to ED, patients classified according to whether visited for medical purposes, or non-medical purposes such as issuance of medical certificates, copying records or DOA. Non-medical purpose visited patients do not undergo KTAS classification. Children and adults include elderly are evaluated on different criteria. Those aged 15 and over are classified as adults. Screening takes places within 3 to 5 s whether they have critical first look or conditions such as mental status change of Glasgow coma scale $<$8 points, severe breathing difficulties, shock status or cardiac arrest by KTAS qualified person. At the same time, screening for the infectious disease took place to decide on isolation. In this serious situation, the patient is classified as KTAS level 1 (a condition which threatening life and requiring immediate treatment) and enter the resuscitation area of ED directly for immediate medical care. For most noncritical patients, severity classification is performed starting consideration of chief complaint of patients. After additional considering various factors including vital signs, level of consciousness, pain scores, mechanism of injury, and blood sugar levels and age of patients, initial KTAS level is determined.

After the KTAS level is determined, the severity of patients is re-evaluated during waiting time or even during the treatment. According to the guidelines, it is recommended that level 1 patients continue to be treated without delay; level 2 should be re-evaluated every 10 min and every 30 min for level 3, every 60 min for level 4, and every 120 min for level 5. Thus, the KTAS level can change if new information is learned during treatment or if patients' symptoms and vital signs are changed. In addition, when patients leave the ED for discharge or hospital admission, the KTAS level is re-calculated for the final KTAS level. Therefore, KTAS level at initial ED presenting and KTAS level at ED discharge reflecting what was up or down triage during the treatment process are recorded at EMR and transmitted to NEDIS.

2.3. Baseline characteristics

All data was collected from the NEDIS and EMR. Study variables included the general and clinical characteristics of patients such as age, sex and vital signs at initial ED presentation including systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse rate (PR), respiratory rate (RR), body temperature (BT) and mental status of patients. Altered mental status was defined as Glasgow coma scale 3 to 8 points. Initial KTAS level at ED present and final KTAS level at ED discharge was also collected. On this basis, we investigated whether KTAS has up-triaged in the ED. And the length of stay (minute) on ED, ED disposition whether the patient was discharged, in-ED mortality, and hospitalization data (ICU admission, in-hospital mortality, hospital length of stay (LOS)) was collected.

2.4. Outcome measure

To determine the prognosis for each age group at the same KTAS triage level, admission rate, ICU admission rate, in-hospital mortality, hospital LOS were compared at each KTAS level. The optimal cut-off values, sensitivity, specificity, and area under the receiver operating characteristics (AUROC) of KTAS level were analyzed, for the clinical results of each patient group which include admission, ICU admission, in-hospital mortality.

In order to compare the adequacy of KTAS between the two groups, the optimal cut-off value, sensitivity, specificity, and area under the receiver operating characteristics (AUROC) were analyzed. The optimal cut-off value has been defined as the point at which the value of "sensitivity+specificity-1" has been maximum (Youden's index) (Perkins and Schisterman, 2006). AUROC levels between 0.8 and 0.9 are indicated good, between 0.7 and 0.8 are indicated suitable, and between 0.6 and 0.7 are indicates low predictive capability (Hajian-Tilaki, 2013). For predict up-triage of KTAS, univariate and multivariate logistic regression analysis was used for the general and clinical characteristics of patients.

2.5. Statistical analysis

Categorical variables are expressed as counts and percentages, and continuous variables are expressed as mean with standard deviation (SD). The independent *t*-test or Mann –Whitney *U* test was used for continuous variables, such as age, distance, and time variables. Pearson's chi-square test or the Fisher's exact test was used for nominal variables. Continuous variables are expressed as the means ± SD or median (interquartile range [IQR]), and categorical variables are expressed as number and percentage. Univariate logistic regression was used to compare neurological prognosis in patients whom ROSC was achieved. Differences with $p < 0.05$ were considered statistically significant. Statistical analyses were performed using IBM SPSS statistics version 26.0 (IBM Corporation, Armonk, NY, USA) and the analysis of the AUROC curves was done by the DeLong method using the MedCalc statistical software version 19 (MedCalc Software Bvba, Ostend, Belgium).

3. Result

3.1. General and clinical characteristics

The final number of enrolled patients during the study period was 87,220 in the adult group and 37,627 in the elderly group (Fig. 1). General characteristics of patients were shown in Table 1. Median age was 41 ± 13.74 in adult group and 76.7 ± 7.56 at elderly group ($p <$ 0.001). Male proportion was 43.3 % (37,794) at adult group and 45.4 % (17,094) at elderly group ($p = 0.001$). The adult group had statistically

Table 1
The general and clinical characteristics of patients by age group.

Variable	Adult group (18–64 years)	Elderly group (over 65 years)	
	$n = 87,220$	$n = 37,627$	*p*-Value
Age (years) [a]	41 ± 13.74	76.7 ± 7.56	**<0.001**
Sex [b]			**0.001**
Male	37,794 (43.3)	17,094 (45.4)	
Female	49,426 (56.7)	20,533 (54.6)	
Vital sign [a]			
Systolic blood pressure (mmHg)	133.45 ± 24.69	138.2 ± 32.14	**<0.001**
Diastolic blood pressure (mmHg)	80.29 ± 15.37	74.86 ± 17.92	**<0.001**
Pulse rate (beats/min)	87.1 ± 18.46	86.08 ± 21.09	**<0.001**
Respiratory rate (breath/min)	19.81 ± 2.12	20.1 ± 3.27	**<0.001**
Body temperature (°C)	36.63 ± 2.17	36.36 ± 3.82	**<0.001**
Altered mental status [b]	1438 (1.6)	2524 (6.7)	**<0.001**
KTAS Triage category [b]			**<0.001**
Level 1 Resuscitation	259 (0.3)	393 (1)	
Level 2 Emergent	4623 (5.3)	5023 (13.4)	
Level 3 Urgent	39,058 (44.8)	21,810 (58)	
Level 4 Less urgent	36,377 (41.7)	8859 (23.5)	
Level 5 Non urgent	6896 (7.9)	1536 (4.1)	
KTAS Uptriage in ED	1080 (1.2)	712 (1.9)	**<0.001**
ED LOS (min) [c0]	173.22 ± 129.83	251.6 ± 192.68	**<0.001**
ED Disposition [b]			**<0.001**
Discharge [b]	69,828 (80.1)	20,367 (54.1)	
In-ED mortality [b]	42 (0.0)	172 (0.5)	
Admission [b]	17,392 (19.9)	17,260 (45.9)	
ICU admission [b]	3030 (17.4)	4540 (26.3)	**<0.001**
In-hospital mortality [b]	516 (3)	1547 (9)	**<0.001**
Hospital LOS (Day) [c]	6 (4.00–11.00)	10 (6.00–19.00)	**<0.001**

KTAS: Korean Triage and Acuity Scale; ED: Emergency department; LOS: length of stay; ICU: intensive care unit.
[a] The values are given as mean ± standard deviation.
[b] The values are given as number (%).
[c] The values are given as median (interquartile range).

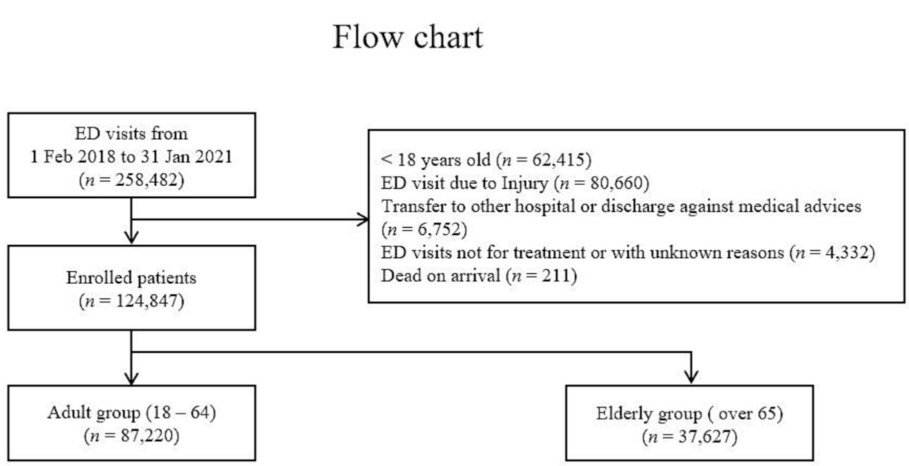

Fig. 1. Study patient flow chart.

significant lower systolic blood pressure (133.45 ± 24.69 vs 138.2 ± 32.14 mmHg, $p < 0.001$) and respiratory rate (19.81 ± 2.12 vs 20.1 ± 3.27, $p < 0.001$), higher diastolic blood pressure (80.29 ± 15.37 vs 74.86 ± 17.92 mmHg, $p < 0.001$) pulse rate (87.1 ± 18.46 vs 86.08 ± 21.09, $p < 0.001$) and body temperature (36.63 ± 2.17 vs 36.36 ± 3.82, $p < 0.001$). Proportion of altered mental status patients was lower in adult group (1.7 %, 1438) compared to elderly group (6.7 %, 2524) and there were statistically significant differences between two groups ($p < 0.001$). KTAS levels 1 and 2, which mean higher urgency, were more common in the elderly group and there were statistically significant differences between two groups ($p < 0.001$). The proportion of KTAS untriaged in ED was 1.2 % (1080) in adult group and 1.9 % (712) in elderly group and there was statistically significant difference between two groups ($p < 0.001$). ED LOS was 173.22 ± 129.83 min at adult group and 251.6 ± 192.68 min at elderly group and there were statistically significant differences ($p < 0.001$). Discharged rate was 80.1 % (69,828) in adult group and 54.1 % (20,367) in elderly group and there were statistically significant differences between two groups ($p < 0.001$). In-ED mortality (0.0 % [42] vs 0.5 % [172]) and admission rate (19.9 % [17,392] vs 45.9 % [17,260]) was higher at elderly group compared to adult group and there were statistically significant differences between two groups ($p < 0.001$). At admission result, more proportion of patients admitted to ICU (17.4 % [3030] vs 26.3 % [4540]) and in-hospital mortality (3 % [516] vs 9 % [1547]) in elderly group ($p < 0.001$). Hospital LOS were statistically significant long in elderly group (6 days [4.00–11.00] vs 9 days [6.00–19], $p < 0.001$).

3.2. Compared prognosis between adult and elderly group by KTAS

The admission rate, ICU admission rate, in-hospital mortality, and hospital LOS between the two groups was compared for each KTAS (Table 2). KTAS level 1, adult group was 254 patients and elderly group was 368 patients. Admission rate was statistically significant higher in adult group (71.7 % [182] vs 50 % [184], $p < 0.001$). ICU admission rate was higher in adult group but there were no statistically significant differences (93.4 % [170] vs 89.7 % [165], $p = 0.200$). In-hospital mortality was higher in elderly group and there were statistically significant differences (29.7 % [54] vs 41.8 % [77], $p = 0.015$). Hospital LOS was longer in elderly group but there were no statistically significant differences (9 days [4.00–19.00] vs 11 days [3.00–21.25], $p = 0.619$). KTAS level 2, adult group was 4597 patients and elderly group was 4913 patients. Admission rate was statistically significant higher in elderly group (51.6 % [2371] vs 74 % [3637], $p < 0.001$). ICU admission rate was higher in elderly group but there were no statistically significant differences (56.9 % [1348] vs 74 % [3637], $p = 0.397$). In-hospital mortality was higher in elderly group and there were statistically significant differences (8.1 % [192] vs 16.3 % [593], $p < 0.001$). Hospital LOS was longer in elderly group and there were statistically significant differences (7 days [5.00–18.00] vs 12 days [6.00–23.00], $p < 0.001$). KTAS level 3, adult group was 39,037 patients and elderly group was 21,776 patients. Admission rate was statistically significant higher in elderly group (27.1 % [10,590] vs 50.7 % [11,049], $p < 0.001$). ICU admission rate was statistically significant higher in elderly group (13.2 % [1397] vs 19.1 % [2109], $p < 0.001$). In-hospital mortality was statistically significant higher in elderly group (2.2 % [230] vs 7.1 % [788], $p < 0.001$). Hospital LOS was statistically significant longer in elderly group (6 days [4.00–11.00] vs 10 days [6.00–18.00], $p < 0.001$). KTAS level 4, adult group was 36,377 patients and elderly group was 8856 patients. Admission rate was statistically significant higher in elderly group (11.1 % [4045] vs 25 % [2212], $p < 0.001$). ICU admission rate was statistically significant higher in elderly group (2.7 % [109] vs 6.8 % [150], $p < 0.001$). In-hospital mortality was statistically significant higher in elderly group (0.9 % [37] vs 3.8 % [85], $p < 0.001$). Hospital LOS was statistically significant longer in elderly group (5 days [4.00–9.00] vs 9 days [5.00–16.00], $p < 0.001$). KTAS level 5, adult group was 6896 patients and elderly group was 1536 patients. Admission rate was statistically significant higher in elderly group (2.9 % [203] vs 11.5 % [177], $p < 0.001$). ICU admission rate was higher in elderly group but there were no statistically significant differences (3 % [6] vs 4 % [7], $p = 0.593$). In-hospital mortality was higher in elderly group but there were no statistically significant differences (1.5 % [3] vs 2.3 % [4], $p = 0.572$). Hospital LOS was statistically significant longer in elderly group (7 days [5.00–13.00] vs 9 days [5.00–18.00], $p = 0.042$).

Table 2
Comparison of patient prognosis by age within KTAS category.

Variable	Adult group (18–64 years)	Elderly group (over 65 years)	
	$n = 87,171$	$n = 37,449$	p-Value
KTAS triage level 1	$n = 254$	$n = 368$	
Admission[a]	182 (71.7)	184 (50)	**<0.001**
ICU admission[a]	170 (93.4)	165 (89.7)	0.200
In-hospital mortality[a]	54 (29.7)	77 (41.8)	**0.015**
Hospital LOS [b]	9 (4.00–19.00)	11 (3.00–21.25)	0.619
KTAS triage level 2	$n = 4597$	$n = 4913$	
Admission[a]	2371 (51.6)	3637 (74)	**<0.001**
ICU admission[a]	1348 (56.9)	2108 (58)	0.397
In-hospital mortality [a]	192 (8.1)	593 (16.3)	**<0.001**
Hospital LOS [b]	7 (5.00–18.00)	12 (6.00–23.00)	**<0.001**
KTAS triage level 3	$n = 39,047$	$n = 21,776$	
Admission[a]	10,590 (27.1)	11,049 (50.7)	**<0.001**
ICU admission[a]	1397 (13.2)	2109 (19.1)	**<0.001**
In-hospital mortality[a]	230 (2.2)	788 (7.1)	**<0.001**
Hospital LOS [b]	6 (4.00–11.00)	10 (6.00–18.00)	**<0.001**
KTAS triage level 4	$n = 36,377$	$n = 8856$	
Admission[a]	4045 (11.1)	2212 (25)	**<0.001**
ICU admission[a]	109 (2.7)	150 (6.8)	**<0.001**
In-hospital mortality[a]	37 (0.9)	85 (3.8)	**<0.001**
Hospital LOS [b]	5 (4.00–9.00)	9 (5.00–16.00)	**<0.001**
KTAS triage level 5	$n = 6896$	$n = 1536$	**<0.001**
Admission[a]	203 (2.9)	177 (11.5)	**<0.001**
ICU admission[a]	6 (3)	7 (4)	0.593
In-hospital mortality[a]	3 (1.5)	4 (2.3)	0.572
Hospital LOS [b]	7 (5.00–13.00)	9 (5.00–18.00)	**0.042**

KTAS: Korean Triage and Acuity Scale; ED: Emergency department; LOS: length of stay; ICU: intensive care unit.
[a] The values are given as number (%).
[b] The values are given as median (interquartile range).

3.3. Cut-off value, AUROC, sensitivity and specificity for predict prognosis by age

Cut-off value for predict admission was 3 in both adult group and elderly group (Table 3). The sensitivity and specificity were 75.57 %/55.93 % and 86.16 %/39.64 % for each group. AUROC was 0.686 and 0.667 in adult and elderly group. Cut-off value for predict ICU admission was 3 in adult group and 2 in elderly group. The sensitivity and specificity was 96.20 %/51.29 % and 50.08 %/90.86 % for each group. AUROC was 0.842 for adult group and 0.767 in elderly group. Cut-off value for predict in-hospital mortality was 2 in both groups. The sensitivity and specificity was 47.67 %/94.69 % and 43.31 %/87.16 % for each group. AUROC was 0.809 in adult group and 0.711 in elderly group (Fig. 2).

3.4. Up-triage predictors

Logistic regression analysis was performed to identify the factors of

Table 3
Cut-off value, AUROC, sensitivity and specificity for predict prognosis by age group.

	Cut-off value	AUROC (95 % CI)	Sensitivity, % (95 % CI)	Specificity, % (95 % CI)
Adult group (18–64 years)				
For predict admission	3	0.686 (0.682–0.690)	75.57 (74.9–76.2)	55.93 (55.6–56.3)
For predict ICU admission	3	0.842 (0.836–0.848)	96.20 (95.5–96.9)	51.29 (51.0–51.6)
For predict in-hospital mortality	2	0.809 (0.792–0.827)	47.67 (43.3–52.1)	94.69 (94.5–94.8)
Elderly group (over 65 years)				
For predict admission	3	0.667 (0.662–0.671)	86.16 (85.6–86.7)	39.64 (39.0–40.3)
For predict ICU admission	2	0.767 (0.761–0.774)	50.08 (48.6–51.5)	90.86 (90.5–91.2)
For predict in-hospital mortality	2	0.711 (0.700–0.722)	43.31 (40.8–45.8)	87.16 (86.8–87.5)

AUROC: Area under the ROC curve, ICU: Intensive care unit.

up-triage group. Respiratory rates, body temperature, altered mental status are investigated as irrelevant to up-triage. Elderly group, male sex, lower SBP and DBP, higher pulse rate, longer ED LOS are more in up-triage group. Multivariate analysis is performed to investigate the up-triage factors and elderly, male sex, pulse rate, ED LOS was appeared to be relevant to up-triage (Table 4).

4. Discussion

Our study suggests that the initial KTAS triage level of patient visits showed poorer performance in the elderly group compared to the adult group. The up-triage rate was higher in the elderly than in adults. In logistic regression analysis, age (the elderly group) also found to be the most influential factor in up-triage. This is the result that elderly patients are becoming more under-triaged than adults, which is similar to previous studies (Ruge et al., 2019). As shown in the AUROC, KTAS performance for prognosis prediction showed lower discriminatory ability in overall admission, ICU admission, and in-hospital mortality in the elderly group than in the adult group. These findings suggest that KTAS presents inappropriate triage in elderly patient.

Globally, overcrowding in emergency rooms has a poor effect on the prognosis of patients (Guttmann et al., 2011; Pines and Hollander, 2008; Sills et al., 2011). Therefore, in order to select severe patients and efficiently utilize limited medical resources, it is important to predict initial urgency using the triage scale. Previous studies have shown that the triage scale can predict short-term mortality and distinguish patients staying at ED for >24 h, and that the more overcrowded, the less waiting time for urgent patients compared to non-urgent patients, thus, the triage priority system is effective in overcrowded situations (Cremonesi et al., 2015; Martins et al., 2009). However, with respect to accuracy and efficiency, there were several challenges with the triage scale. Even with specialized training, early classification of patients into five stages has a variety of problems, including limited information, various patient symptoms and conditions, and eventually intuitive and subjective intervention. In fact, some studies have demonstrated that reliability was low as well as the effect of classification was different depending on

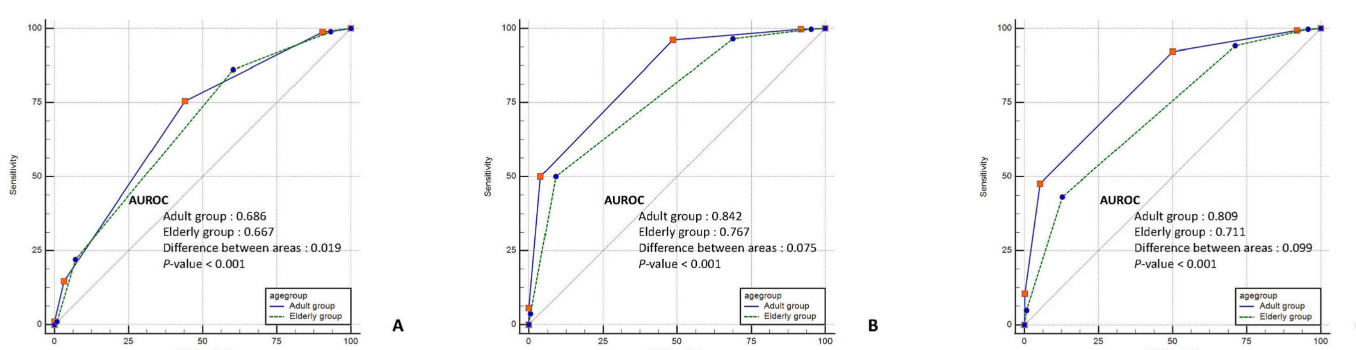

Fig. 2. Comparison of the AUROCs curve between two groups.
A. For predicting overall admission.
B. For predicting ICU admission.
C. For predicting in-hospital mortality.

Table 4
Logistic regression analysis of up-triage predictors.

Variable	Univariate analysis[a]			Multivariate analysis[b]		
	Non-uptriage group	Uptriage group				
	$n = 123{,}055$	$n = 1792$	*p*-Value	OR	B	*p*-Value
Age, elderly group (over 65 years) [b]	36,915 (30)	712 (39.7)	**<0.001**	1.317 (1.193–1.454)	0.275	**<0.001**
Sex; Male [b]	54,009 (43.9)	879 (49.1)	**<0.001**	1.209 (1.100–1.328)	0.189	**<0.001**
Systolic Blood Pressure (mmHg) [a]	134.92 ± 27.18	132.41 ± 30.96	**<0.001**	0.999 (0.996–1.001)	−0.001	0.362
Diastolic Blood Pressure (mmHg) [a]	78.69 ± 16.34	76.2 ± 18.59	**<0.001**	0.993 (0.990–0.996)	−0.007	**<0.001**
Pulse rate (beats/min) [a]	86.78 ± 19.29	87.88 ± 19.52	**0.016**	1.003 (1.001–1.005)	0.003	**0.029**
Respiratory rate (breath/min) [a]	19.9 ± 2.53	19.94 ± 2.65	0.544			
Body temperature (°C) [a]	36.55 ± 2.78	36.6 ± 2.11	0.495			
Altered mental status [b]	3895 (3.2)	67 (3.7)	0.170			
ED LOS (min) [a]	195.8 ± 154.8	268.31 ± 198.33	**<0.001**	1.001 (1.001–1.001)	0.001	**<0.001**

ED: Emergency department; LOS: length of stay.
[a] The values are given as mean ± standard deviation.
[b] The values are given as number (%).

the classifier (Han et al., 2010; Mistry et al., 2018; Wuerz et al., 1998). Therefore, in the field of emergency medicine, research on the proposal of the new triage system as well as the validation of the existing triage system continued (Levin et al., 2018; McLeod et al., 2021).

There have been previous studies to verify the validity of CTAS-based TTAS and JTAS as well as KTAS (Chen et al., 2022; Kuriyama et al., 2019; Ng et al., 2011). In particular, Akira Kuriyama et al. attempted to verify the suitability of JTAS with adult and elderly targets in each of the two studies (Kuriyama et al., 2018; Kuriyama et al., 2019). Overall, in both studies, the prognosis of patients and the triage level of JTAS were good associated, but in a study of the elderly, the overall admission prediction ability was found to be slightly lower (Kuriyama et al., 2019). And this is a similar result to this study and supports our research. However, the marked advantage of this study was that it able to reduce the bias according to the classifier because we compared the suitability of adults and the elderly, planned with the same design and same duration.

According to other studies, MTS and ESI also reported lower triage performance in the elderly compared to adults, as in JTAS (Brouns et al., 2019; Hinson et al., 2019; Zachariasse et al., 2017). It is difficult to make accurate decisions of urgency in a short unless the classifier has a deep understanding or experience of the characteristics of the elderly. Because this problem was known, a study on age-adjusted triage was recently conducted. Kirsi Kemp et al., conducted a study by moving elderly patients to the more severe category, and they found the triage performance was improved (Kemp et al., 2022). This finding suggests that changes may be needed in the existing triage system, which classifies only adults and children. In 2017, guidance for applying CTAS to a geriatric patient were published. This guide provides considerations for physiological change, cognitive imposition, atypical presentation, polypharmacy of elderly patients and examples of certain cases of geriatric patients (Bullard et al., 2017). Perhaps because of their concept and efforts, in study on a CTAS, only 2 % of elderly patients with immediate life-threatening events were classified as moderate acuity (level 3) (Lee et al., 2011). As research on the application of KTAS for elderly patients has just begun, guidelines considering the characteristics of Korean elderly patients, or if necessary, research on a new classification system for adjusting age for elderly patients may be conducted.

Both up-triages and under-triages are miss-triages, however, up-triages are more important in terms of patient safety. This is because the severity of the patient was initially underestimated, and the up-triage was performed due to finding the urgency during the clinical process. In particular, it becomes more serious when targeting the elderly patients who are predicted to have a relatively poor prognosis. In this study, multivariate analysis revealed that patients aged 65 or older were the most influential factors in up-triage, raising concerns. It should be thought that in patients with age 65 and over, likely to be higher severity level than the actual KTAS level given at first.

This study has some limitations that should be considered. First, as in other previous studies, we verified the triage scale system, KTAS through the severity of patients such as overall admission and ICU admission rate, mortality rate, and length of hospital stay (Kuriyama et al., 2018; Kuriyama et al., 2019; Ng et al., 2011). However, the triage scale was initially designed to evaluate the patient's urgency, and when visiting the ED for initials, it received a high grade such as KTAS 1 and 2 due to unstable vital signs, etc., but may have been discharged from the ED after treatment. Patient urgency and severity may be not identical. Second, even if a classifier receives the same training content and is certified for specialized qualifications, there may be differences in scoring according to individual characteristics or hospital policies. In order to overcome this difference, research was conducted at the two centers, but it may be necessary to conduct multi-center research as a follow-up study. Last, the triage was classified in five grades, and the cut-off value was obtained by attempting a prognosis evaluation using this. However, we do not think that there is the same interval difference in predicting patient severity at each stage. The score showing the cut-off value seems to be a level that requires attention, not an accurate cut score.

5. Conclusion

Our study suggested that the level of KTAS triage has a poor association with prognostic prediction in elderly than adult patients. In addition, the possibility of up-triage in the clinical process was higher in the elderly patient, suggesting that severity and urgency should not be underestimated in patients aged 65 or older when initially weighing the triage scale.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declarations of competing interest

None.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CRediT authorship contribution statement

Ho Sub Chung: Conceptualization, Methodology, Project administration. **Myeong Namgung:** Data curation, Writing – review & editing. **Dong Hoon Lee:** Investigation, Formal analysis, Validation, Resources. **Yoon Hee Choi:** Supervision, Formal analysis, Methodology. **Sung Jin Bae:** Writing – original draft, Writing – review & editing, Resources.

Data availability

Data will be made available on request.

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