American Journal of Emergency Medicine 37 (2019) 2159–2164

Contents lists available at ScienceDirect

American Journal of Emergency Medicine

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

Validity of the Japan Acuity and Triage Scale in elderly patients: A cohort study

Akira Kuriyama MD, MPH *, Toshie Kaihara BA, Tetsunori Ikegami MD

Emergency and Critical Care Center, Kurashiki Central Hospital, Japan

ARTICLE INFO

Article history:
Received 28 January 2019
Received in revised form 26 February 2019
Accepted 7 March 2019

Keywords:
Age
Elderly
Japan triage and acuity scale
Observational study
Triage

ABSTRACT

Background: In developed nations, the age of patients in emergency departments (ED) continues to increase. Many emergency triage systems, such as the Canadian Triage and Acuity Scale (CTAS), triage patients as a homogenous group, regardless of age. However, older adults have multiple comorbidities and a higher risk of undertriage. The Japan Acuity and Triage Scale (JTAS) was developed based on the CTAS and has been validated for overall adults. We assessed the validity of the JTAS for use in elderly ED patients.

Methods: This was a secondary analysis of a cohort study that previously validated the JTAS in self-presenting adults of all ages in the ED of a Japanese tertiary-care hospital. We included non-transferred patients who were ≥65 years old and triaged between June 2013 and May 2014. Our primary outcome measures were overall admission and ED length of stay. Our secondary outcomes included admission to the intensive care units (ICUs) and in-hospital mortality. We examined the association between the triage level and patient outcomes with multivariable logistic regression analysis (overall and ICU admission and in-hospital mortality) and the Kruskal-Wallis rank-sum test (ED length of stay).

Results: We included a total of 11,087 elderly patients in our study. Higher odds ratios for overall and ICU admission and in-hospital mortality corresponded to higher acuity levels. ED length of stay was significantly longer in patients with a higher JTAS level ($p < 0.001$). Twenty-nine percent of admissions who were triaged as lower acuity levels were related to non-acute diseases including malignancy-related events.

Conclusion: Our study suggests an association between the JTAS triage level and clinical outcomes in self-presenting elderly patients, thereby demonstrating the validity of the JTAS in these patients. However, admission due to chronic diseases including malignancy was common in patients who were rated as low acuity level.

1. Introduction

Developed nations are graying. Elderly patients comprise 12–24% of all emergency department (ED) visits [1-4]. Older adults have multiple comorbidities and a higher risk of hospital admission and mortality [4-7]. Nonetheless, they are likely to present with non-specific complaints, to be misdiagnosed, to remain untreated for an unrecognized entity, and to encounter adverse events [3,8-11]. As a result, geriatric emergency medicine has increasingly focused on advocating for systems of more efficient care for elderly patients to account for complex backgrounds [11-15].

Triage systems categorize patients according to the urgency of care needed (acuity), thereby prioritizing patients and optimizing resources in the ED. Five-level emergency triage systems, such as the Canadian Triage and Acuity Scale (CTAS), are used worldwide. Overall, triage systems such as the CTAS are designed to screen all patients evenly, despite heterogeneity; in other words, younger and older patients will receive the same screening. However, only a few studies have examined the validity of triage systems specifically for elderly patients in the ED [16-20]. In Japan, the Japan Triage and Acuity Scale (JTAS) is a validated, five-level triage system that is based on the CTAS and has been used nationwide [21]. However, to the best of our knowledge, the JTAS has not been validated for use in elderly ED patients.

Abbreviations: AUROC, Areas under the receiver operating characteristic curves; CTAS, Canadian Triage and Acuity Scale; ED, Emergency department; ICU, Intensive care unit; JTAS, Japan Triage and Acuity Scale; ROC, Receiver operating characteristic.

* Corresponding author at: Emergency and Critical Care Center, Kurashiki Central Hospital, 1-1-1 Miwa Kurashiki, Okayama 710-8602, Japan.

E-mail address: akira.kuriyama.jpn@gmail.com (A. Kuriyama).

https://doi.org/10.1016/j.ajem.2019.03.006
0735-6757/

Therefore, this cohort study aimed to examine the validity of the JTAS in elderly ED patients. We used data from a large cohort of self-presenting adults, which were previously used to validate the JTAS for use in Japan [21].

2. Methods

2.1. Japan Triage and Acuity Scale

The JTAS was developed in 2012 by the Japanese Society for Emergency Medicine, the Japanese Association for Acute Medicine, the Japanese Society for Emergency Pediatrics, and the Japanese Association for Emergency Nursing; the JTAS is based on the CTAS with some modifications for the local context [21]. Specifically, since heat-related illness and post-vaccination syndrome are common in Japan, a triage process for these entities was added to the existing CTAS framework. The JTAS has been utilized in many Japanese emergency departments (EDs) since its introduction [21]. The JTAS evaluation begins with 17 main complaints and 165 subordinate, specific complaints. Primary modifiers according to vital signs, pain, and mechanism of injury help nurses to assign an appropriate triage level to a patient. Occasionally, special modifiers for certain complaints or groups of complaints help refine their prioritization. JTAS then assigns a patient to one of five levels of acuity: level 1, resuscitation; level 2, emergent; level 3, urgent; level 4, less urgent; and level 5, nonurgent. As in the CTAS, the JTAS also recommends the time to care by physicians for each level: immediate (level 1); within 10 min (level 2); within 30 min (level 3); within 60 min (level 4); and within 120 min (level 5).

2.2. Study design and setting

This was a secondary analysis of a cohort study that examined the validity of the JTAS in adults; the protocol is reported elsewhere [21]. Briefly, the primary cohort study examined self-presenting patients aged 16 years or older who visited the ED of a 1131-bed tertiary-care center in western Japan between June 1, 2013 and May 31, 2014. Approximately 70,000 patients, including both adults and children, are annually examined at the ED of this hospital, about 9000 of whom are transferred by ambulance. In the previous study, we found that higher triage levels corresponded to a greater risk of overall admissions, admissions to intensive care units (ICUs), and longer ED stays. Thus, the validity of JTAS in overall adult patients was demonstrated. The current study focused on patients aged 65 year or older, whom we defined as elderly patients.

This study was approved by the institutional review board of the participating hospital. Individual informed consent was waived because the data were originally intended for clinical practice and thereafter deidentified for the research purpose.

2.3. Measurements

At the entrance to the ED, triage nurses triaged all self-presenting patients with the help of a computer-based software that is compliant with the JTAS, except when triage nurses were unavailable. When a patient was registered at the ED, the information for each ED visit was simultaneously registered in the database of the ED. The information included patient identification number, age, sex, and the time of the visit. The triage level was then recorded in the database as the triage nurses assigned each patient to a triage level. The ED clerks documented the final disposition (death, admission, or discharge to home from the ED) in the database with the time of its occurrence. This constituted the dataset collected at the ED.

The information related to patient prognosis (in-hospital mortality) of admitted patients was added to the dataset after manually reviewing their medical charts. This data was then deidentified for research purpose and was previously used to validate the JTAS in adults.

Patients transferred by ambulance were immediately examined by ED physicians in our ED; they were not triaged with JTAS.

2.4. Participant selection

Patients who met the following criteria were included in our study: 1) ≥65 years of age; 2) triaged during the 1-year study period (June 2013 through May 2014); and 3) either admitted, dead, or discharged from the ED. Patients who were not triaged, those who were transferred by ambulance, or those who left without being seen were excluded.

2.5. Outcomes

Overall admissions and ED length of stay are the most common outcomes used to validate triage systems [22]. We therefore used overall admission and ED length of stay as our primary outcomes. Overall admission was defined as hospitalization in the intensive care units (ICUs) or general wards and death in the ED. ED length of stay was defined as the time of arrival at the ED to the final disposition (death, admission, or discharge from the ED). Our secondary outcomes were admission to the ICUs and in-hospital mortality. In-hospital mortality included death in the ED or during the hospitalization.

Our institution has several ICUs according to diseases. Clinicians commonly share the following indications for admission to ICUs: 1) altered mental status or use of sedatives that require airway protection; 2) respiratory failure that necessitates mechanical ventilation; 3) circulatory failure that requires circulatory assist device and/or hourly titration of fluids, vasopressors, and inotropes; 4) severe metabolic disorders, electrolytes disturbances, or acute medical diseases that require close monitoring of vital signs; and 5) emergency or elective surgeries of high-risk patients that require close monitoring of vital signs. Thus, ICU admissions were uniformly determined unless there were limitations to active or intensive treatment.

In this study, we defined as undertriage as participants who were rated level 4 or 5 but were admitted because overall admission was the primary outcome. We described the characteristics of a random sample of such patients.

2.6. Statistical analysis

We examined the associations between triage level and dichotomous patient outcomes (overall admission, ICU admission, and in-hospital mortality) and ED length of stay. The association between triage level and dichotomous outcomes was evaluated using multivariable logistic regression analysis that was adjusted with patients' age, the time of visit, and JTAS levels, according to previous studies [17,21,23]. As a small number of patients were admitted from JTAS levels 4 and 5, we merged these two patient groups and made this group the reference. The association between triage level and ED length of stay was assessed using the Kruskal-Wallis rank-sum test. We also examined the predictive value of JTAS for dichotomous outcomes using receiver operating characteristic (ROC) curves and determined the areas under the ROC curve (AUROCs). In this study, $p < 0.05$ was considered significant. All analyses were performed using Stata (version 15.1; StataCorp, College Station, TX, USA).

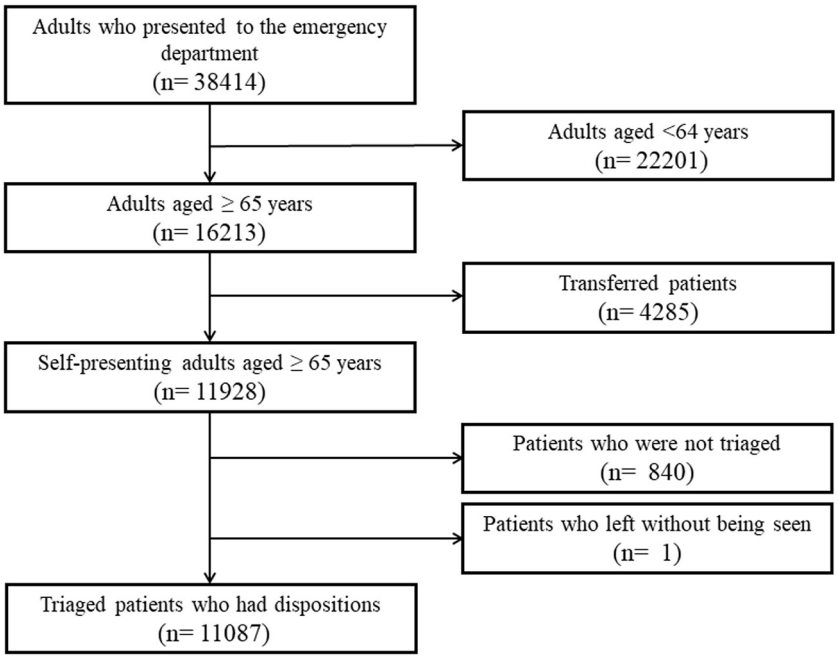

Fig. 1. Patient selection.

3. Results

3.1. Characteristics of the study participants

A total of 38,414 adult participants visited the ED during the 1-year study period, and 22,201 (57.8%) were younger than 65 years old. After eliminating 4285 participants who were transferred by ambulance, 840 who were not triaged, and one who left without being seen, a total of 11,087 participants were finally included in our analysis (Fig. 1). The baseline characteristics of the participants are shown in Table 1. The median age of the participants was 76 years, and 5542 (50.0%) participants were female. Many of the ED visits occurred between 8:30 AM and 4:30 PM (51.0%), and 36.3% of the participants visited the ED on weekends and holidays. Triage levels 3 and 4 were the most common (45.2% and 39.9%, respectively). A total of 2096 (18.9%) patients were admitted: 1891 and 205 were admitted to general wards and ICUS, respectively, whereas 2 died in the ED and 109 died during the hospitalization.

Table 1
Baseline characteristics of the participants

Characteristics	
No. of participants	11,087
Median age, years (first, third quartile)	76 (70, 82)
Age category	
65–69	4884 (44.1%)
70–79	4417 (39.8%)
80–89	1678 (15.1%)
90–	108 (1.0%)
Female, *n* (%)	5545 (50.0)
Shift of arrival, *n* (%)	
Day (8:30 AM–4:30 PM)	5650 (51.0)
Evening (4:30 PM–0:30 AM)	3902 (35.2)
Night (0:30 AM–8:30 AM)	1535 (13.8)
Day of week	
Weekdays	7057 (63.7)
Weekends/holidays	4030 (36.3)
Triage level, *n* (%)	
1	82 (0.7)
2	959 (8.7)
3	5010 (45.2)
4	4422 (39.9)
5	614 (5.5)
Median ED length of stay, minutes (first, third quartile)	158 (99, 238)
Final disposition, *n* (%)	
Admission to ICUs	205 (1.8)
Admission to general wards	1891 (17.1)
Death	2 (0.02)
Discharged	8989 (81.1)

Abbreviation: ED, emergency department; ICU, intensive care unit.

3.2. Primary outcomes

Multivariable logistic regression analysis revealed that the odds ratio for overall admission was greater with a higher JTAS level compared to JTAS levels 4 and 5 combined (the lowest acuity levels) (Table 2).

The ED length of stay for each JTAS level is given in Fig. 2. The Kruskal-Wallis rank-sum test for the ED length of stay by JTAS level was significant ($\chi^2 = 1241.84$; df = 4; $p < 0.001$).

The discriminative ability of the JTAS for overall admission, as shown in the AUROC, was 0.688 (95% CI, 0.677–0.700) (Fig. 3).

3.3. Secondary outcomes

Multivariable logistic regression analysis for ICU admission and in-hospital mortality also revealed that the odds ratio for each outcome was greater with a higher JTAS level compared to the reference group (JTAS levels 4 and 5 combined) (Table 2). The AUROCs for ICU admission and in-hospital mortality were 0.745 (95% CI, 0.712–0.777) and 0.705 (95% CI, 0.663–0.747), respectively (Fig. 3).

3.4. Undertriage

We examined a random sample of 100 among 458 patients who were rated as level 4 or 5 but were eventually admitted (data is available upon request). The reason for admission included acute

Table 2
Overall admission and intensive care unit admission and in-hospital mortality for each level of Japan Triage and Acuity Scale.

Overall Admission					
JTAS level	No. of patients	No. of overall admission (*n*, %)	OR for overall admission	95% CI	*p*-Value
1	82	71 (86.6%)	65.33	34.19–124.85	<0.001
2	959	424 (44.2%)	8.33	7.08–9.80	<0.001
3	5010	1155 (23.0%)	3.08	2.74–3.47	<0.001
4 + 5	5036	448 (8.9%)	Reference		
ICU Admission					
JTAS level	No. of patients	No. of ICU admission (*n*, %)	OR for ICU admission	95% CI	*p*-Value
1	82	21 (25.6%)	67.77	35.94–127.79	<0.001
2	959	65 (6.8%)	14.31	9.02–22.70	<0.001
3	5010	95 (1.9%)	3.77	2.43–5.83	<0.001
4 + 5	5036	26 (0.5%)	Reference		
In-hospital mortality					
JTAS level	No. of patients	No. of in-hospital mortality (*n*, %)	OR for in-hospital mortality	95% CI	*p*-Value
1	82	13 (15.9%)	66.91	30.01–149.17	<0.001
2	959	18 (1.9%)	7.00	3.47–14.15	<0.001
3	5010	66 (1.3%)	4.85	2.72–8.66	<0.001
4 + 5	5036	14 (0.3%)	Reference		

Abbreviations: JTAS, Japan Triage and Acuity Scale; OR, odds ratio; CI, confidential interval; ICU, intensive care unit.
Percentages in the parenthesis represent the proportion of the events per the number of patients for each category. Patients who died in the emergency department were counted as the occurrence of the outcome and were included in these analyses. Multivariable logistic regression analysis adjusted with patients' age and the time of visit was used.

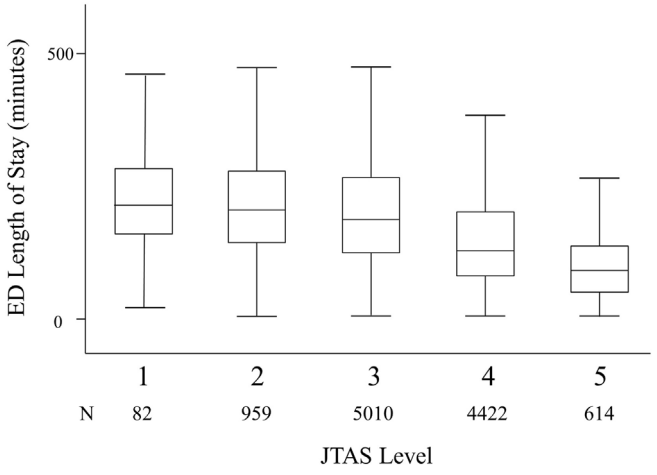

Fig. 2. Length of ED stay. The box plots indicate the median (line in the box), the interquartile range (box), and the smallest and largest values that are not >1.5 times the interquartile range away from the first and third quartile, respectively (whiskers).

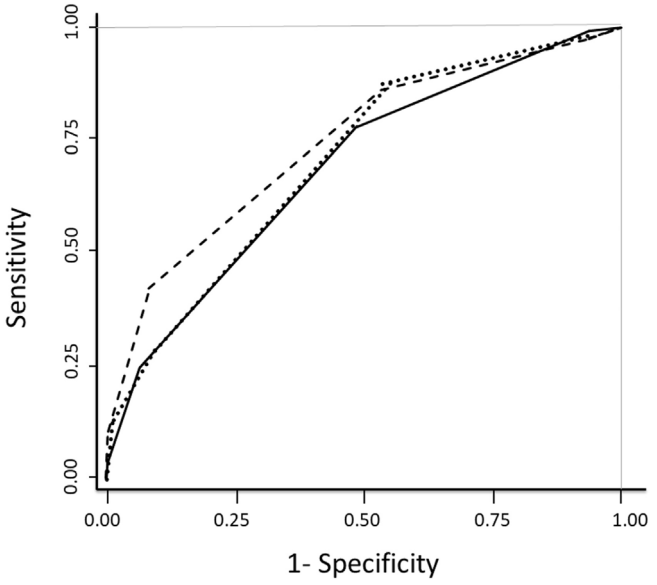

Fig. 3. Receiver operating characteristic curves of the JTAS levels and overall admission (continuous line), admission to the ICU (dashed line), and in-hospital mortality (dotted line).

diseases (71%; e.g., infections, ileus, bleeding, vertebral fracture and associated myelopathy) and non-acute diseases (29%; e.g., decreased appetite due to hyponatremia or dehydration, newly-identified or terminal-stage malignancy). Twenty-five percent of such patients were associated with events after chemotherapy or malignancy that was newly-identified or terminal stage. Non-specific complaints, including malaise, decreased appetite, and immobility, were found in 17% of such patients and were frequently associated with infection or malignancy.

4. Discussion

Our study suggests a good association between JTAS triage levels and patient outcomes (overall admission, ED length of stay, ICU admission, and in-hospital mortality) in elderly patients. The JTAS also demonstrated fairly good discriminative ability, as shown by the AUROC, for ICU admission and in-hospital mortality, although the discriminative ability for overall admission was slightly lower. These findings demonstrate the validity of the JTAS for elderly patients.

Validation studies of emergency triage systems often share a common challenge. As it is hard to determine the reference standards of acuity, most previous studies have evaluated the validity of triage systems by investigating the association of the triage level with a marker of severity, such as admission, resource use, or ED length of stay [22]. These studies examine an unspoken hypothesis that, as the triage level is higher (more emergent), the patient

outcomes are more severe. Many of the previous studies on the CTAS and other triage systems examined the association between triage levels and markers of severity to determine the validity of the triage system [17,19,23-29]. Similarly, our study found that, as the JTAS level was higher, overall admission and ED length of stay increased, as did ICU admission and in-hospital mortality.

In determining the discriminative ability of the JTAS, the AUROCs for overall admission and ICU admission in all adults were 0.726 and 0.792 [21], respectively, while the AUROCs for these same markers in elderly patients were slightly smaller: 0.688 and 0.745, respectively. A similar phenomenon was reported in a study of the German version of the Emergency Severity Index [17,23]. Grossman et al. conducted a single-center prospective study on unselected, consecutive patients who presented to the ED [23]. The AUROCs for overall and ICU admission were 0.788 and 0.856, respectively. Grossman et al. further conducted a secondary analysis of this cohort by focusing on patients aged ≥65 years, as we did in the current study [17]. The AUROCs for overall and ICU admission slightly decreased to 0.741 and 0.749, respectively [17]. There are several potential reasons for this decrease in the discriminative ability of triage systems, with the most likely being that the deteriorated physiological response to stress with ageing [30,31] and an increased frequency of non-specific complaints [8-11] in elderly patients might make it difficult for clinicians to appropriately assess and triage these patients.

In our study, overtriage was defined as discharge from the ED to home in patients with higher JTAS levels, whereas undertriage represented admission in those with lower JTAS levels. Generally, it is more important to avoid undertriage than overtriage. Among undertriaged cases in our study, nearly 30% of the cases had non-acute diseases, many of which were associated with malignancy or non-specific complaints. This trend is consistent with the characteristics of elderly patients in general. Clinicians thus need to be aware that a certain proportion of elderly patients who are assigned to lower acuity levels might be associated with chronic diseases but could be admitted.

Each outcome measure has its merits and demerits with respect to clinical interpretation in studies of triage systems [22]. Overall admission is the most commonly assessed outcome. However, overall admission can occur for non-medical reasons, such as the living status of a patient, and severity is more weighted than acuity in overall admission. In contrast, ICU admission could represent both the severity and acuity of a patient's status. However, patients, particularly the elderly, can opt for non-invasive treatment or place limitations on the intent of active treatment given life expectancy or pre-morbid physical status [32]. We might fail to assess patient acuity if the ICU admission was the primary focus, due to exclusion of patients with treatment limitations. In-hospital mortality indicates the worst severity outcome and could include all critical cases regardless of treatment limitations. In the current study, an association was demonstrated between the JTAS triage level and in-hospital mortality as well as between the JTAS triage level and overall and ICU admission; therefore, the validity of the JTAS for elderly patients was robust regardless of treatment limitations. This is the main strength of our study.

Although a few studies have attempted to modify the JTAS, the validity and effectiveness of the original version of the JTAS have rarely been evaluated since its introduction in 2012. In a time series study, Hamamoto et al. showed that the time from registration to triage, duration of triage, and time from registration to physician examination were significantly reduced after the introduction of the JTAS [33]. Our previous work demonstrated the validity of JTAS in adults aged ≥16 years [21]. Hence, studies that elucidate the limitations of the JTAS, such as undertriage in older adults, are necessary.

Our study has some limitations. First, patient acuity and severity are not identical, but we assessed the JTAS using only markers of severity. For example, patients with anaphylaxis might be rated as JTAS level 1 or 2 for urgent care but could be discharged from the ED if outcomes are uneventful with treatment. If many such cases existed in our dataset, which were not particularly severe but needed urgent management, this might have lowered the sensitivity of the JTAS. However, a systematic review suggested that many validation studies of triage systems evaluate validity using severity markers; as mentioned above, this is a common limitation shared by studies of triage systems [22]. Second, the patients that were not triaged and thereafter excluded from the analysis had less severe conditions compared to triaged patients. This might have underestimated the specificity of the JTAS. Third, our study did not examine patients transferred by ambulance. Generally, those transferred by ambulance tend to have higher acuity in comparison with self-presenting patients. Studies to validate the JTAS in such patients are warranted. Fourth, we did not adjust for some factors, such as ED volume or hospital occupancy, in the analysis of the ED length of stay as such data were not available. Fifth, we did not assess inter-rater reliability from the current data. However, as stated earlier, triage nurses in our institution assess patients using a software that is standardized for JTAS. It has been shown that the decisions of triage nurses who were using a computer-based tool that is compliant with a triage system had higher agreement with a consensus standard than those using memory-based triage [34]. Thus, the quality of the triage decisions might have been relatively uniform. Finally, this study was a single-center study. Although our institution is the largest tertiary-care hospital in Japan, our findings might not necessarily be generalizable to other settings or nations. However, the CTAS, on which the JTAS was developed, has been validated in several countries [19,35-37]. Hence, given that the CTAS is known to be applicable across disease structures and cultures, the JTAS may be applicable in other Japanese settings. However, testing the generalizability of the JTAS is still warranted.

5. Conclusions

Our study suggests a fairly good association between JTAS triage levels and clinical outcomes in self-presenting elderly patients, thereby demonstrating the validity of the JTAS for use in elderly patients. The discriminative ability of the JTAS may, however, be lower in elderly patients than in adults overall.

Declarations of interest

None to declare.

Funding

None.

References

[1] Salvi F, Morichi V, Grilli A, et al. The elderly in the emergency department: a critical review of problems and solutions. Intern Emerg Med 2007;2:292–301.
[2] Hu SC, Yen D, Yu YC, et al. Elderly use of the ED in an Asian metropolis. Am J Emerg Med 1999;17:95–9.
[3] Gruneir A, Silver MJ, Rochon PA. Emergency department use by older adults: a literature review on trends, appropriateness, and consequences of unmet health care needs. Med Care Res Rev 2011;68:131–55.
[4] Samaras N, Chevalley T, Samaras D, et al. Older patients in the emergency department: a review. Ann Emerg Med 2010;56:261–9.
[5] Marengoni A, Angleman S, Melis R, et al. Aging with multimorbidity: a systematic review of the literature. Ageing Res Rev 2011;10:430–9.
[6] Vogeli C, Shields AE, Lee TA, et al. Multiple chronic conditions: prevalence, health consequences, and implications for quality, care management, and costs. J Gen Intern Med 2007;22(Suppl. 3):391–5.

[7] Fortin M, Soubhi H, Hudon C, et al. Multimorbidity's many challenges. BMJ 2007;334:1016–7.
[8] Raven MC, Lowe RA, Maselli J, et al. Comparison of presenting complaint vs discharge diagnosis for identifying "nonemergency" emergency department visits. JAMA 2013;309:1145–53.
[9] Sauter TC, Capaldo G, Hoffmann M, et al. Non-specific complaints at emergency department presentation result in unclear diagnoses and lengthened hospitalization: a prospective observational study. Scand J Trauma Resusc Emerg Med 2018;26:60.
[10] Djarv T, Castren M, Martenson L, et al. Decreased general condition in the emergency department: high in-hospital mortality and a broad range of discharge diagnoses. Eur J Emerg Med 2015;22:241–6.
[11] Wachelder JJH, Stassen PM, Hubens L, et al. Elderly emergency patients presenting with non-specific complaints: characteristics and outcomes. PLoS One 2017;12:e0188954.
[12] Bellou A, Conroy SP, Graham CA. The European curriculum for geriatric emergency medicine. Eur J Emerg Med 2016;23:239.
[13] Ringer T, Dougherty M, McQuown C, et al. White paper-geriatric emergency medicine education: current state, challenges, and recommendations to enhance the emergency care of older adults. AEM Educ Train 2018;2:S5–S16.
[14] Puig Campmany M, Bustamante Araujo M, Blazquez Andion Josep Ris Romeu M, et al. Opportunity for emergency medicine and geriatric-orthopedic specialists to improve the emergency department care of elderly patients. Emergencias 2019;31:70–1.
[15] Kahn JH, Magauran Jr BG, Olshaker JS, et al. Current trends in geriatric emergency medicine. Emerg Med Clin North Am 2016;34:435–52.
[16] Baumann MR, Strout TD. Triage of geriatric patients in the emergency department: validity and survival with the Emergency Severity Index. Ann Emerg Med 2007;49:234–40.
[17] Grossmann FF, Zumbrunn T, Frauchiger A, et al.: At risk of undertriage? Testing the performance and accuracy of the emergency severity index in older emergency department patients. Ann Emerg Med 2012;60:317–325 e313.
[18] Ichwan B, Darbha S, Shah MN, et al.: Geriatric-specific triage criteria are more sensitive than standard adult criteria in identifying need for trauma center care in injured older adults. Ann Emerg Med 2015;65:92–100 e103.
[19] Lee JY, Oh SH, Peck EH, et al. The validity of the Canadian Triage and Acuity Scale in predicting resource utilization and the need for immediate life-saving interventions in elderly emergency department patients. Scand J Trauma Resusc Emerg Med 2011;19:68.
[20] Platts-Mills TF, Travers D, Biese K, et al. Accuracy of the Emergency Severity Index triage instrument for identifying elder emergency department patients receiving an immediate life-saving intervention. Acad Emerg Med 2010;17:238–43.
[21] Kuriyama A, Ikegami T, Kaihara T, et al. Validity of the Japan Acuity and Triage Scale in adults: a cohort study. Emerg Med J 2018;35:384–8.
[22] Kuriyama A, Urushidani S, Nakayama T. Five-level emergency triage systems: variation in assessment of validity. Emerg Med J 2017;34:703–10.
[23] Grossmann FF, Nickel CH, Christ M, et al. Transporting clinical tools to new settings: cultural adaptation and validation of the Emergency Severity Index in German. Ann Emerg Med 2011;57:257–64.
[24] Dong SL, Bullard MJ, Meurer DP, et al. Predictive validity of a computerized emergency triage tool. Acad Emerg Med 2007;14:16–21.
[25] Gouin S, Gravel J, Amre DK, et al. Evaluation of the Paediatric Canadian Triage and Acuity Scale in a pediatric ED. Am J Emerg Med 2005;23:243–7.
[26] Gravel J, Fitzpatrick E, Gouin S, et al.: Performance of the Canadian Triage and Acuity Scale for children: a multicenter database study. Ann Emerg Med 2013;61:27–32 e23.
[27] Gravel J, Gouin S, Goldman RD, et al.: The Canadian Triage and Acuity Scale for children: a prospective multicenter evaluation. Ann Emerg Med 2012;60:71–77 e73.
[28] Gravel J, Manzano S, Arsenault M. Validity of the Canadian Paediatric Triage and Acuity Scale in a tertiary care hospital. CJEM 2009;11:23–8.
[29] Ma W, Gafni A, Goldman RD. Correlation of the Canadian Pediatric Emergency Triage and Acuity Scale to ED resource utilization. Am J Emerg Med 2008;26:893–7.
[30] Heffernan DS, Thakkar RK, Monaghan SF, et al. Normal presenting vital signs are unreliable in geriatric blunt trauma victims. J Trauma 2010;69:813–20.
[31] Lucke JA, de Gelder J, Clarijs F, et al. Early prediction of hospital admission for emergency department patients: a comparison between patients younger or older than 70 years. Emerg Med J 2018;35:18–27.
[32] Kuriyama A. Capsule commentary on Hayashi et al., Predictors associated with survival among elderly inpatients who receive cardiopulmonary resuscitation in Japan: an observational cohort study. J Gen Intern Med 2019;34:303.
[33] Hamamoto J, Yamase H, Yamase Y. Impacts of the introduction of a triage system in Japan: a time series study. Int Emerg Nurs 2014;22:153–8.
[34] Dong SL, Bullard MJ, Meurer DP, et al. Emergency triage: comparing a novel computer triage program with standard triage. Acad Emerg Med 2005;12:502–7.
[35] Al-Hindi AA, Al-Akhfash AA, Fareed AM, et al. Efficacy of implementation of a 5 scale pediatric triage and acuity scale in pediatric emergency, Saudi Arabia. Saudi Med J 2014;35:999–1004.
[36] Elkum NB, Barrett C, Al-Omran H. Canadian Emergency Department Triage and Acuity Scale: implementation in a tertiary care center in Saudi Arabia. BMC Emerg Med 2011;11:3.
[37] Ng CJ, Hsu KH, Kuan JT, et al. Comparison between Canadian Triage and Acuity Scale and Taiwan Triage System in emergency departments. J Formos Med Assoc 2010;109:828–37.