Reliability and validity of the revised triage sieve in daily emergency medical service situations

SYSTEMATIC REVIEW

ORIGINAL ARTICLE BY

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ABSTRACT

OBJECTIVE

To assess the reliability and the validity of the revised triage sieve in terms of a predictive performance regarding intrahospital death, hospital admission, and ESI.

METHODS

This study is a cross-section diagnostic study determining the reliability and diagnostic performance of the revised triage sieve for intrahospital death, hospital admission, and emergency severity index (ESI).

RESULTS

A total of 552 medical records were included. In terms of reliability, the inter-rater reliability was fair as the weight Kappa 0.54 (95% CI 0.49 to 0.59). The validity of the predictive performance regarding intrahospital death was relatively high (sensitivity 88.2%, 95% CI 63.6 to 98.5; specificity 80%, 95% CI 74.5 to 84.8; AUC 0.83, 95% CI 0.74 to 0.91). The high specificity was also found in hospital admission (80%, 95% CI 74.5 to 84.8) and hospital ESI (83.3%, 95%CI 79.0 to 87.0).

CONCLUSION

The revised triage sieve was one of the reliable and valid scene triage tools.

INTRODUCTION

Triage at the scene is performed initially in out-of-hospital trauma patients in the emergency medical service (EMS) system.[1] Its results would affect the decision of choosing the destination hospital and the emergency levels of transferring.[2–4] The Thai National Institute of Emergency Medicine has issued the criteria-based dispatch for phone triage.[5] Later, the emergency severity index (ESI) was created in 2000 to be used in the emergency room.[4] It is accepted to be the main triage because of its practicality, flexibility, and accuracy.[4,6–8] However, there is no standard scene triage tool as well as there is the evidence shows that the triage tool should be very specific to the scenarios and conditions.[9,10] Many triage tools have been used as scene triage, such as the Trauma index,[11] CRAMS scale,[12] Prehospital Index,[13] Advanced trauma life support field triage scheme,[14,15] The national advisory committee for aeronautics ,[16–18] Modified early warning score,[19] as well as the ESI was also used in the prehospital settings.[20] However, there is no reliable evidence confirmed which tool is superior as compared with one another on treatment outcomes.[21] In 2006, Robertson-steel[22] stated that the triage tool should be suitable and pragmatic for ambulance crew and EMS providers. The complicated triage tool, hence, should be refrained. Triage sieve was developed in 1995 as a part of the major incident medical management and support.[23] Triage sieve has been well known in its easy-to-use and has been adopted as a mass casualty triage for many years.[24,25] It was revised in 2012 to improve its accuracy.[26] The revised version was shown to have higher effectiveness in the military operation compared with that of the previous version.[27,28] The validity of its revised version, nonetheless, has never been assessed in daily EMS situations. Thus, the objective of this study was to assess the validity of the revised triage sieve in the daily emergency medical service situations.

METHODS

STUDY DESIGN

This study is a cross-section diagnostic study determining the reliability and diagnostic performance of the revised triage sieve for intrahospital death, hospital admission, and ESI.

MEDICAL RECORDS

The current study was conducted in an emergency medical service (EMS) system of four provinces in northeastern Thailand including Khon Kaen, Kalasin, Mahasarakham, and Roi-Et. Medical records of the EMS patients between January and August 2017 were reviewed and recorded. We excluded those with incomplete data and died on the scene. The intrahospital death was collected from patients' hospital records as well as the hospital admission. ESI was assessed by an emergency room nurse.

DATA COLLECTION

Aside from intrahospital mortality, hospital admission, and ESI, variables including sex, age, dispatch code, types of injury; trauma or non-trauma, as well as variables regarding the on-scene triage level done by EMS providers; Priority 1 (P1), Priority 2 (P2), and Priority 3 (P3) sieve were

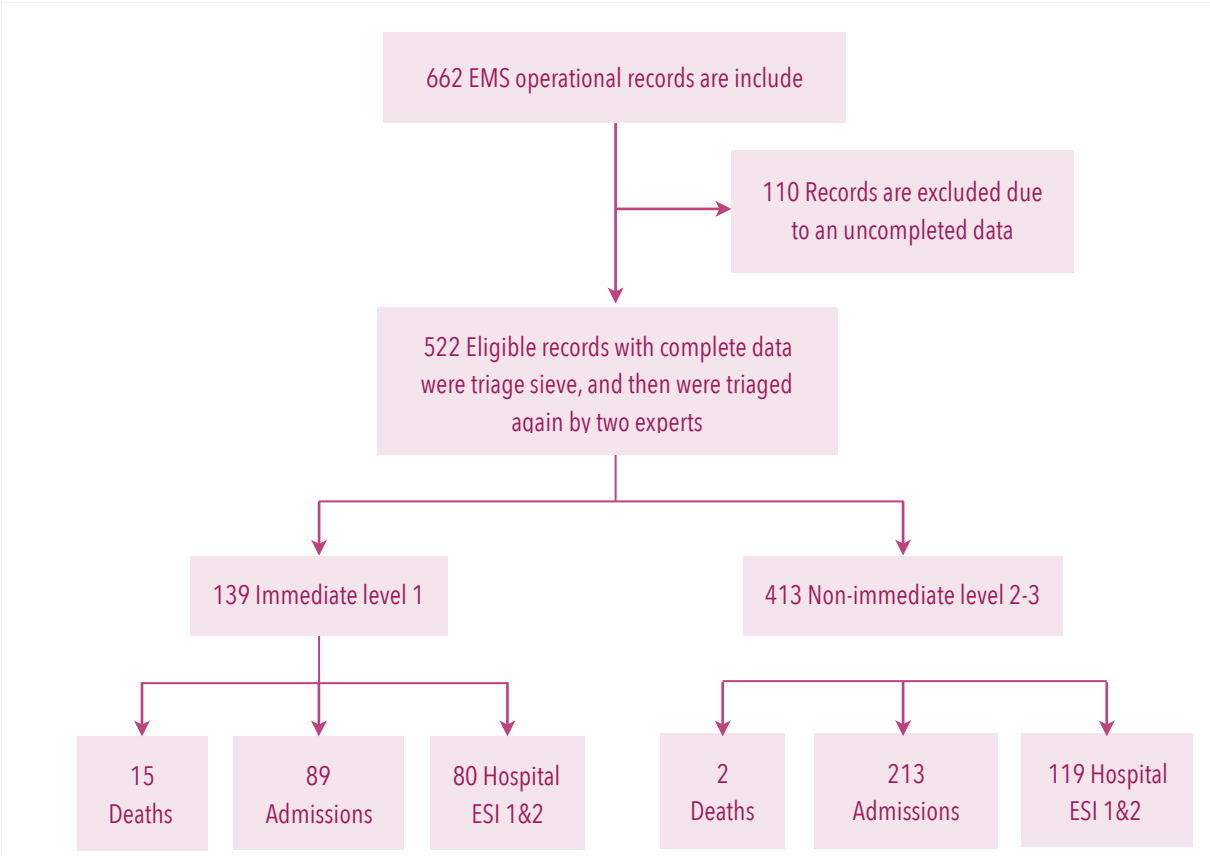

Figure 1. Patients

collected from recording documents; medical records and hospital records. All patients were divided into either immediate groups (P1) and non-immediate groups (P 2 and P3).

STATISTICAL ANALYSIS

All data were entered onto a spreadsheet, cleaned, and verified before the analysis. All characteristic data were analyzed by the Chi-square test, Mann-Whitney U test (continuous data), and Fisher exact test depending on the type of data. The calculated revised triage sieve was performed by two experienced paramedics. If there was some disagreement between them. the triage given in the medical records more would be accepted as the calculated revised triage sieve. The reliability of the revised triage sieve was calculated and presented in weight Kappa. For its validity, including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), likelihood ratio (LR), accuracy, and area under the curve (AUC) together with its 95% confidence interval (CI) were also interpreted regarding the three outcomes; intrahospital death, hospital admission, ESI.

The sample size calculation is based on the sensitivity of our pilot study (N=60) which was 76%. Given 80% of power and 5% alpha error, the required sample would be at least 281. However, the study includes more than 600 patients for the best approximate of the results.

Table 1. Characteristics of the patients

Characteristic		Revised triage sieve		P-value
	Total (n=552)	Immediate (n=139)	Non-immediate (n=413)	
Male sex–no. (%)	311 (56.3)	87 (62.6)	224 (54.2)	0.086[a]
Age-years-no. (%)				0.015[a]
15 or younger	338 (61.2)	73 (52.5)	265 (64.2)	
60 or older	214 (38.8)	66 (47.5)	148 (35.8)	
Median (IQR)	52 (35-68)	59 (37-72)	50 (35-67)	0.023[b]
Dispatch code-no. (%)				<0.001[a]
Priority 1	150 (27.2)	79 (56.8)	71 (17.2)	
Priority 2	331 (60.0)	50 (36.0)	281 (68.0)	
Priority 3	71 (12.9)	10 (7.2)	61 (14.8)	
Trauma-no. (%)	156 (28.3)	40 (28.8)	116 (28.1)	0.876[a]
Intrahospital mortality-no. (%)	17 (3.1)	15 (10.8)	2 (0.5)	<0.001[c]
Hospital admission-no. (%)	302 (54.7)	89 (64.0)	213 (51.6)	0.011[a]
ESI level-no. (%)				<0.001[a]
1	86 (15.6)	43 (30.9)	43 (10.4)	
2	113 (20.5)	37 (26.6)	76 (18.4)	
3	193 (35.0)	41 (29.5)	152 (36.8)	
4	137 (24.8)	16 (11.5)	121 (29.3)	
5	23 (4.2)	2 (1.4)	21 (5.1)	

*Immediate(PO and P1), Non-immediate(P2 and P3), [a]Chi-square test, [b]Mann-Whitney U test, [c]Fisher exact test

Table 2. Matched levels of on-scene and calculated revised triage sieve

Priority	Calculated Revised triage sieve		
Revised triage sieve	**1**	**2**	**3**
		no. (%)	
1	73 (83.9)	46 (16.1)	20 (11.1)
2	9 (10.3)	196 (68.8)	56 (31.11)
3	5 (5.8)	43 (15.1)	104 (57.8)

RESULTS

There were 662 EMS patients included in the study; 110 patients were excluded due to incomplete data. In total, 552 were left in the analysis and were divided into two groups by the on-scene triage level (Figure 1). From Table 1 comparing the immediate and non-immediate groups, the former had a similar age range, a similar proportion of male sex, a similar types of injury, and similar hospital-admission rate (P>0.001). However, the intrahospital death and ESI were significantly different between the two groups (P<0.001).

The matched levels of the onsite and calculated revised triage sieve are presented in Table 2. The best-matched level is P1. Conversely, the percentage of matched level P2 and P3 is over 50%. Inter-rater reliability was described in the weight Kappa, which was 0.54 (95% CI 0.49 to 0.60).

Using the on-scene triage sieve to identify the immediacy of the patients and to prognose the intrahospital mortality, P1 yielded 88.2% sensitivity (95% CI 63.6 to 98.5), 76.8% specificity (95% CI 73.0 to 80.3), PPV 10.8% (95% CI 6.2 to 17.2), NPV 99.5% (95% CI 98.3 to 99.9), positive LR 3.8 (95% CI 3.0 to 4.8), negative LR 0.2 (95% CI 0.04 to 0.6), and Accuracy 77.2 (95% CI 73.4 to 80.6).

For hospital admission as the secondary outcome, P1 reported 29.5 % sensitivity (95% CI 24.4 to 35.0), 80.0% specificity (95% CI 74.5 to 84.8), PPV 64.0% (95% CI 55.5 to 72.0), NPV 48.4% (95% CI 43.5 to 53.4), positive LR 1.5 (1.1 to 2.0), negative LR 0.9 (95% CI 0.8 to 1.0), and Accuracy 52.4% (95% CI 48.1 to 56.6), and for ESI 1 and 2, P1 yielded 40.2% sensitivity (95% CI 33.3 to 47.4), 83.3% specificity (95% CI 79.0 to 87.0), PPV 57.6% (95% CI 48.9 to 65.9), NPV 71.2% (95% CI 66.6 to 75.5), positive LR 2.4 (95% CI 1.8 to 3.2), negative LR 0.7 (95% CI 0.6 to 0.8), and Accuracy 67.8 (95% CI 63.7 to 71.6). The AUC was demonstrated in figure 2. For intrahospital death, the AUC was significantly high as 0.83 (95% CI 0.7 to 0.9) while the AUC for hospital admission and ESI are o.6 (95%CI 0.5 to 0.6), and 0.6 (95% CI 0.6 to 0.7), respectively.

Table 3. Diagnostic performance of on-scene revised triage sieve at priority level 0 and 1 on each outcome

Revised triage sieve	Sensitivity	Specificity	PPV	NPV	LR+	LR-	Accuracy
Intrahospital death	88.2 (63.6 -98.5)	76.8 (73.0-80.3)	10.8 (6.2-17.2)	99.5 (98.3-99.9)	3.8 (3.0-4.8)	0.15 (0.04-0.56)	77.2 (73.4-80.6)
ESI (ESI 1 & 2)	40.2 (33.3-47.4)	83.3 (79.0- 87.0)	57.6 (48.9-65.9)	71.2 (66.6-75.5)	2.4 (1.8-3.2)	0.72 (0.63-0.81)	67.8 (63.7-71.6)
Admission	29.5 (24.4- 35.0)	80 (74.5-84.8)	64 (55.5-72.0)	48.4 (43.5-53.4)	1.5 (1.1-2.0)	0.88 (0.80-0.97)	52.4 (48.1-56.6)

DISCUSSION

PRINCIPAL FINDINGS

According to the finding, the revised triage sieve had moderate inter-rater reliability. The diagnostic performance of the revised triage sieve for intrahospital was high in sensitivity, good in specificity, PPV was quite low, NPV was high, the positive LR was small increase while the negative LR was moderate, and overall accuracy was fair. Notably, the AUC for intrahospital death was good. It seems that the revised triage sieve was able to rule in and rule out the intrahospital death, effectively. Besides, its high sensitivity and high NPV results in a low false negative. The low PPV can be explained by the low prevalence as 3.1% (95% CI 1.8 to 4.9). However, a negative LR power was higher than a positive LR, which indicated the suitability of this tool for ruling-out the diagnosis. In terms of hospital admission, the sensitivity was low but the specificity was good. Both PPV and NPV were fair. Either a positive or negative LR was small and rarely important. The AUC was interpreted as a fail level. Lastly, the overall accuracy is fair. It can be seen that the revised triage sieve was able to rule out the admission because of its high specificity. However, other parameters did not support the diagnostic performance of the tool. Next, for the ESI, the sensitivity was fair and the specificity was high. This supports its ability to rule out the ESI. PPV was quite high while PPV was fair. A positive LR was small as well as the negative LR was small and rarely important. Additionally, the AUC was interpreted as a poor level. It can be concluded that the diagnostic performance for ESI is unacceptable.

COMPARISONS WITH OTHER STUDIES

Due to a relatively small number of studies in this field, related studies are scarce. However, our findings are related to one study which reported the good specificity of this tool.[29] On the other hand, there is one study which indicated the triage sieve was inferior to identify a severe condition compared to other triage tools.[30]

STRENGTHS AND LIMITATIONS OF STUDY

The strength of this study was a multicenter study. It included 600 medical records to improve its quality. Second, this study applied several measurements to test the tool in different aspects.

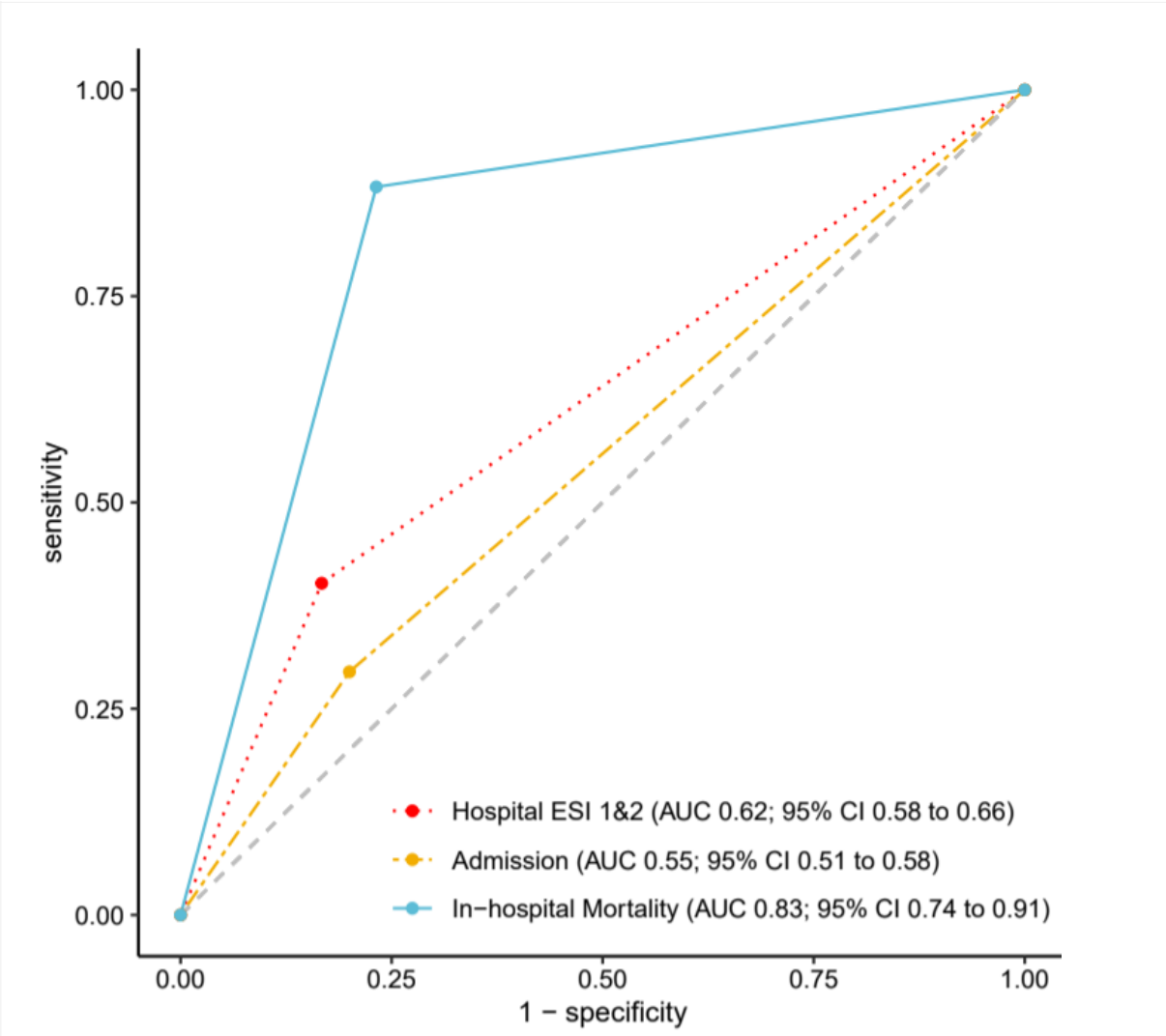

Figure 2. ROC curve of the immediate group

On the other hand, this study has some limitations. The number of medical records in the immediate group is less than the non-immediate group, which might affect the study to investigate the diagnostic performance in that group. Second, the prevalence of the intrahospital death was low which affected PPV as described above. Third, this study is an observational study that is difficult to control the confounding factor.

CONCLUSIONS AND POLICY IMPLICATIONS

The revised triage sieve was relatively reliable. It was useful to estimate the intrahospital death and hospital admission and ESI. Therefore, it was suitable to use as a scene triage in order to fill the gap of EMS service. However, further research should be conducted on a national scale to find out more regarding its reliability and validity.

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