



Original Article

Development and Initial Psychometric Evaluation of a Screening Tool for Taiwan Seniors at Risk (TSAR)

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SUMMARY

Background: Older adults can suffer from adverse outcomes after emergency department (ED) visits, and there are currently no suitable screening tools in Taiwan to identify high-risk older adults in the ED. **Methods:** We developed the Taiwan Seniors at Risk (TSAR) screening tool, consisting of six questions in a straightforward yes/no format. The tool demonstrates a high content validity, with a Content Validity Index of 0.93. A longitudinal study of 135 patients aged ≥ 65 years was conducted in the ED of a tertiary-care medical center in Taiwan. Data collected at baseline included demographic factors, the Taiwan Triage and Acuity Scale, medical diagnoses in the ED, the Charlson Comorbidity Index, TSAR, and the Modified Katz Index of Independence in Activities of Daily Living. Follow-up assessments at 1 month and 3 months after ED visits focused on ED revisits, institutionalization, functional decline, and mortality. **Results:** TSAR had a sensitivity of 0.65 and specificity of 0.64 at 1 month after an ED visit and a sensitivity of 0.63 and specificity of 0.31 at 3 months after an ED visit. Further analysis indicated the area under the curve was 0.67, and the best cut-off point was 2. **Conclusion:** Healthcare providers in ED can use the TSAR to quickly screen and it can serve to identify high-risk groups in need of targeted assessment and early intervention.

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1. Introduction

In 2021, 32% of all emergency department (ED) visits in Taiwan were by patients aged 65 and older, contributing to 41% of overall ED costs.¹ Older adults are the most rapidly growing group of patients visiting ED, and they have significantly increased risks of adverse outcomes after an ED visit, including revisits, hospitalizations, functional decline, and mortality.² Early detection of older adults at risk of adverse outcomes using a screening tool in ED is crucial because it can identify high risk groups in need of targeted assessment and early intervention.

Several screening tools have been developed to identify older adults at high risk of adverse outcomes after ED visits, including the Identification of Seniors at Risk (ISAR) and the Triage Risk Stratification Tool (TRST). Carpenter et al. (2015) conducted a systematic review and meta-analysis to evaluate the prognostic accuracy of ED-validated screening instruments for distinguishing older adults likely to experience adverse outcomes. The findings revealed that none of the published risk stratification instruments — such as ISAR, TRST,

Variables Indicative of Placement, Runciman instrument, Rowland instrument, and Silver Code — demonstrated sufficient prognostic accuracy to effectively identify high-risk subsets of older adults in ED settings.³ Subsequent systematic reviews and meta-analyses further emphasize that current screening tools fall short in accurately identifying high-risk older adults in the ED, with no single tool serving as an independent and reliable predictor of adverse outcomes.⁴ In Taiwan, Hsu et al. (2023) evaluated the Chinese version of the ISAR screening tool and recommended incorporating additional variables to improve its predictive accuracy to a moderate level.⁵

Despite concerns about prognostic accuracy, the existing screening tools were developed in Western countries, which differ significantly from Taiwan in terms of healthcare systems and healthcare-seeking behaviors. Therefore, ongoing research is essential to develop and validate a specific, localized screening tool for identifying older adults at risk of adverse outcomes following an ED visit in Taiwan.

2. Methods

2.1. Study design and participants

We conducted a longitudinal study; potential participants were

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identified in the emergency room of a tertiary-care medical center in Taiwan. Patients were eligible for inclusion if they were 65 or older, had Taiwan Triage and Acuity Scale (TTAS) levels between 2 and 5, and were able to communicate independently. The exclusion criteria were as follows: (1) trauma patients, (2) patients admitted due to severe acute illness (requiring immediate intensive care), (3) patients needing hospice care, (4) patients diagnosed with mental illness, and (5) long-term bedridden patients.

2.2. Screening Tool for Taiwan Seniors at Risk (TSAR)

Potential TSAR screening items were determined using the following steps: (1) an extensive literature review of screening tools for adverse outcomes in older adults after an ED visit, (2) adaptation of items from existing screening tools,^{6–11} (3) modification and reduction of the items by an expert panel, and (4) examination of TSAR content validity.

In Step 3, an expert panel consisting of three emergency physicians and geriatricians, who are the authors of this study, reviewed the items on existing screening tools for their clinical applicability and feasibility in the emergency department setting in Taiwan. The panel met twice, after which point a consensus was reached, and 7 items were chosen for the initial TSAR screening tool: needing assistance with, or reminders about, toilet use or bathing, presence of subjective cognitive decline, nutritional status, 8 or more prescription medications, 2 or more falls in the past year, staying in the ED for observation more than 6 hours or hospitalization within the previous 90 days, and available of a support system. In Step 4, content validity was assessed by five experts in geriatric care, who were invited by the first author via email. The panel included specialists in geriatrics, emergency medicine, emergency nursing, pharmacy, and nutrition. They independently evaluated the importance and clarity of the initial seven items, resulting in the removal of the item “nutritional status”. Ultimately, a six-item screening tool was developed, achieving a content validity index (S-CVI) of 0.93.

2.3. Measures at baseline

Before data collection, the study was approved by the Institutional Review Board of the Chi Mei Hospital (IRB No. 11103-008). Data were collected from May, 2022 to November, 2022 by the first author. Data collection took place from May to November 2022, led by the first author, who visited the ED Monday through Friday to recruit eligible patients. Written informed consent was obtained prior to data collection. Following consent, the first author reviewed medical records and conducted face-to-face interviews with participating patients at their bedside. The baseline data collected included demographic factors (e.g., age, gender, marital status, and educational level) and health conditions (e.g., TTAS, medical diagnosis in the ED, the Charlson Comorbidity Index, TSAR, and the Modified Katz Index of Independence in Activities of Daily Living).

2.3.1. Taiwan Triage and Acuity Scale (TTAS)

The TTAS is based on the framework of the Canadian Triage and Acuity Scale, modified to suit the Taiwanese healthcare context. It classifies patients into five urgency levels: 1 = resuscitation, 2 = emergency, 3 = urgent, 4 = less urgent, and 5 = non-urgent, each with a corresponding safe waiting time. The TTAS is divided into two main categories: “trauma” and “non-trauma”, which are further subdivided into 14 systems encompassing a total of 163 chief complaints used for classification. It demonstrates high consistency and inter-rater reliability, with an expert content validity index ranging from

0.8 to 1.0. Additionally, the TTAS exhibits strong sensitivity of 92.2% and specificity of 97.3%.^{12,13}

2.3.2. Charlson Comorbidity Index (CCI)

The CCI, originally designed to classify prognostic comorbidity, has been widely used to represent comorbidity severity. Nineteen diseases are weighted based on the severity of the prognosis. Scores range from 0 to 37, with a higher score indicating increased severity of comorbidity. The CCI score has been reported to be a predictor for one-year mortality.¹³

2.3.3. Screening Tool for Taiwan Seniors at Risk (TSAR)

The TSAR is designed to detect adverse health outcomes in older adults following an ED visit. This straightforward screening tool is tailored to fit the context of Taiwan’s social and healthcare insurance systems. The self-administered TSAR comprises six items, employing a dichotomous response scale (0 = Yes; 1 = No), with one negatively worded item reverse-scored. Total scores range from 0 to 6, with higher scores indicating an increased risk of adverse outcomes for older adults. Preliminary evidence demonstrates a content validity index (CVI) of 0.93 for the TSAR.

2.3.4. Modified Katz Index of Independence in Activities of Daily Living (Modified Katz ADL)

The Modified Katz ADL is an instrument for assessing the daily living ability of older adults. The self-administered Katz ADL consists of 7 items with a 3-point Likert-type response scale (0 = totally dependent; 2 = independent). A high Katz ADL score indicates a high level of daily living ability.¹⁴

2.4. Measures at 1-month and 3-months after ED visit

Follow-up variables were collected via telephone interviews conducted 1-month and 3-months after the ED visit. The adverse outcomes defined include the following conditions: ED revisits, institutionalization, functional decline, and death. These criteria were adapted from a previous study.¹⁵ An ED revisit was defined as a return to the ED with the same related symptom. Institutionalization was defined as patient admission to a nursing home when he/she did not reside in one before the ED visit. Functional decline was defined as a negative value obtained by subtracting the 1-month or 3-months score from the baseline score of the Modified Katz ADL.

2.5. Statistical analysis

The data were analyzed using IBM SPSS Statistics 22 software. Baseline demographic factors (e.g., age, gender, marital status, and educational level) and health conditions (e.g., TTAS, medical diagnosis in the ED, the CCI, TSAR, and the Modified Katz ADL) were displayed using frequencies, percentages, and mean and standard deviations. When evaluating the predictive validity of the TSAR screening tool, a receiver operating characteristic (ROC) curve was constructed to estimate its sensitivity and specificity. Moreover, the optimal cut-off point of the TSAR was obtained from the area under the curve (AUC). Based on the cut-off point of the TSAR, the participants were classified into 2 levels of risk for adverse outcomes: low and high. Then independent *t* tests and Chi-square tests were used to examine whether the optimal cut-off point of the TSAR could significantly distinguish participants with different demographic factors and health conditions. All results were considered statistically significant at a *p* value < 0.05.

3. Results

In total, 135 older adults in the ED were enrolled in the study (Table 1). The dropout rate of this study was 17.7%. Dropout was due to an inability to contact the patient ($n = 24$). Data collection was completed for 113 older adults 1 month after ED visits. Thirty-six patients (31.9%) had adverse health outcomes including ED revisits (14.2%), institutionalization (1.8%), functional decline (17.7%), and death (3.5%). Moreover, 111 older adults were followed up 3 months after ED visits; of these, 48 patients (43.2%) had adverse health outcomes including ED revisits (25.2%), institutionalization (2.7%), functional decline (24.3%), and death (3.6%).

The predictive validity was assessed using ROC curve analysis, with a sensitivity of 0.65 and specificity of 0.64 1 month after an ED visit and a sensitivity of 0.63 and specificity of 0.313 months after an ED visit. Further analysis indicated the AUC was 0.67, and the best

cut-off point was a TSAR score of 2 points. Compared with the low-risk group ($TSAR \leq 2$), older adults in the high-risk group ($TSAR > 2$) were significantly older (78.28 ± 8.03 vs. 72.87 ± 6.26 ; $p < 0.001$), had more emergencies at the TTAS level (46.9% vs. 28.2%; $p = 0.045$), had more comorbidities (2.22 ± 1.30 vs. 1.65 ± 1.20 ; $p = 0.009$), and were less likely to be independent in ADL (10.41 ± 3.45 vs. 13.49 ± 1.48 ; $p < 0.001$) (Table 2).

4. Discussion

In this study, the TSAR was developed and examined for its initial psychometric properties. We also compared the difference between demographic factors and health conditions by cut-off point of this newly developed screening tool. Our finding, that the TSAR can predict adverse outcomes in older adults after an ED visit as well as the existing screening tools (e.g., ISAR, TRST, Rowland questionnaire, Runciman questionnaire, and Brief Risk Identification for Geriatric Health Tool), which gave results between 'no value' (AUC = 0.51) and 'acceptable' (AUC = 0.73).^{6-9,15-22} Furthermore, using the best cut-off point of the TSAR score allowed discrimination between the high-risk group of older adults with particular traits, such as older-age, emergency conditions, more chronic disease, and ADL dependence.

In 2013, Cousins et al. conducted a systematic review and analysis of the TRST screening tool, focusing on older adults aged 65 and above who were discharged from the ED. They included six studies involving a total of 3,233 older adults and used a TRST score of at least 2 to identify high-risk patients. When a score of 2 or higher was used as the threshold for high risk, the sensitivity of TRST for adverse outcomes within 1 month was 0.58 and the specificity was 0.61.¹⁵ In 2015, Yao et al. conducted a systematic literature review on the ISAR screening tool, including 10 studies with a total of 8,680 participants. The accuracy of the ISAR in predicting adverse outcomes for older adults after discharge from the ED was rated as poor to fair. Specifically, the accuracy of ISAR ranged from 0.58 to 0.74.¹⁶ In 2017, Galvin et al. conducted a systematic literature review and meta-analysis of ISAR screening tool, including 32 prospective or retrospective cohort studies involving a total of 12,939 participants. The results indicated that when using a score of 2 or higher as the risk threshold, ISAR demonstrated the following sensitivity and specificity for predicting ED revisit rates, hospitalization, functional decline, and mortality within 1 month: sensitivity 0.81 to 0.97 and specificity 0.24 to 0.38.¹⁷ Rivero-Santana et al. (2017) also conducted a systematic review and meta-analysis on the predictive accuracy of ISAR and TRST, including 25 relevant studies. Among these, 12 studies used ISAR alone, 5 used

Table 1. Patient characteristics ($n = 135$).

Characteristics	n (%) / M \pm SD
Demographic factors	
Age, years	75.44 \pm 7.63
Gender, female	71 (52.6%)
Educational level	
Illiterate	34 (25.2%)
Elementary/Junior high school	84 (62.2%)
Senior high school	12 (8.9%)
College and above	5 (3.7%)
Marital status, married	90 (66.7%)
Health conditions	
TTAS	
Level 2	50 (37.0%)
Level 3	76 (56.3%)
Level 4	7 (5.2%)
Level 5	2 (1.5%)
Medical diagnosis in ED	
Infectious disease	56 (41.5%)
Gastrointestinal disease	27 (20.0%)
Neurological disease	11 (8.1%)
Other	9 (6.7%)
Urinary and reproductive disease	8 (5.9%)
Cardiovascular disease	7 (5.2%)
Respiratory disease	7 (5.2%)
Musculoskeletal disease	7 (5.2%)
Blood and hematopoietic system disease	3 (2.2%)
CCI	1.92 \pm 1.28
TSAR	2.64 \pm 1.21
Modified Katz ADL score	12.00 \pm 2.90

CCI, Charlson Comorbidity Index; ED, emergency department; Modified Katz ADL, Modified Katz Index of Independence in Activities of Daily Living; TSAR, Taiwan Seniors at Risk; TTAS, Taiwan Triage and Acuity Scale.

Table 2. Comparison of demographic factors and health conditions between 2 groups.

Variable	TSAR ≤ 2 ($n = 71$)	TSAR > 2 ($n = 64$)	t test/ χ^2 test	p-values
Demographic factors				
Age, mean \pm SD	72.87 \pm 6.26	78.28 \pm 8.03	-4.385	< 0.001
Male, n (%)*	37 (52.1%)	27 (42.2%)	1.330	0.249
Female, n (%)*	34 (47.9%)	37 (57.8%)		
Married, n (%)*	51 (71.8%)	39 (60.9%)	1.791	0.180
Educational level, n (%)*			0.29	0.40
Illiterate/Elementary/Junior high school	63 (88.7%)	56 (87.5%)		
Senior high school/College and above	8 (11.3%)	5 (12.5%)		
Health conditions				
TTAS, n (%)			8.065	0.045
Level 2	20 (28.2%)	30 (46.9%)		
Level 3	47 (66.2%)	29 (45.3%)		
Level 4/Level 5	4 (5.6%)	5 (7.8%)		
CCI	1.65 \pm 1.20	2.22 \pm 1.30	-2.65	0.009
Modified Katz ADL	13.49 \pm 1.48	10.41 \pm 3.45	6.86	< 0.001

* Fisher's Exact Test.

CCI, Charlson Comorbidity Index; Modified Katz ADL, Modified Katz Index of Independence in Activities of Daily Living; TSAR, Taiwan Seniors at Risk; TTAS, Taiwan Triage and Acuity Scale.

TRST alone, and 8 used both screening tools. The results indicated sensitivity of the ISAR scoring system ranged from 0.67 to 0.99, while its specificity ranged from 0.21 to 0.41. For TRST, sensitivity ranged from 0.52 to 0.75 and specificity from 0.39 to 0.51.¹⁸ In 2019, Schwab conducted a systematic literature review in the United States comparing the performance of the TRST and ISAR in identifying the risk of early unplanned readmission among hospitalized patients aged 65 and older. This study analyzed 12 pieces of literature and found significant differences between the two tools in terms of sensitivity and specificity. TRST demonstrated a higher specificity range (0.21 to 0.63) but a lower sensitivity range (0.62 to 0.87). In contrast, ISAR showed a higher sensitivity range (0.79 to 0.91) but a lower specificity range (0.19 to 0.40). The AUC for ISAR ranged from 0.60 to 0.69, while the AUC for TRST was lower, ranging from 0.48 to 0.65.¹⁹

The aforementioned studies indicated that none of the published risk stratification instruments, such as ISAR or TRST, exhibited sufficient prognostic accuracy to effectively identify high-risk subsets of older adults in ED. Furthermore, these existing screening tools were developed in Western countries, which have significantly different healthcare systems and healthcare-seeking behaviors compared to Taiwan. The results of this study suggest that TSAR may be well-suited for Taiwan, offering a rapid assessment method for identifying high-risk older adults in ED and supporting early intervention and care planning. By initiating screening and fostering interdisciplinary collaboration in ED, TSAR enhances the delivery of timely, high-quality care, ultimately improving patient outcomes and preserving quality of life.

There were some limitations in the present study. First, the patients were recruited using the convenience sampling method at a single medical center in Tainan City. Therefore, the representativeness of the present sample is restricted and cannot be generalized. Future studies are needed to examine if the TSAR possesses good psychometric properties in a more heterogeneous sample group. Second, the present study did not examine several psychometric properties of the TSAR, including inter-rater reliability, criteria validity, construct validity, and responsiveness. Therefore, it is unclear if the reproducibility of the TSAR is satisfactory. Finally, TSAR was developed as a self-administered screening tool. Older adults diagnosed with mental illness may influence the accuracy of the report and were therefore excluded from this study. Further studies are needed to design an appropriate screening tool that accommodates this population and addresses their specific needs, ensuring comprehensive assessment and support.

5. Conclusion

The present study showed that TSAR is a simple screening tool consistent with Taiwan's social, healthcare insurance, and system contexts. It has acceptable predictive validity for a variety of adverse outcomes and also good known-group validity. Healthcare providers in ED can use the TSAR to quickly screen the overall conditions of older adults. Further in-depth assessment in specific domains and appropriate interventions can then be conducted.

Conflicts of interest

The authors have no conflicts of interest relevant to this article.

Ethical consideration

The study was approved by the Institutional Review Board of the Chi Mei Hospital (IRB No. 11103-008).

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