EVALUATION AND COMPARISON OF SCREENING TOOLS USED TO PREDICT THE ADVERSE OUTCOMES OF ELDERLY PATIENTS IN THE EMERGENCY DEPARTMENT

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ABSTRACT

Introduction*: The proportion of the geriatric population, who visited the emergency departments (EDs) more frequently and with more complicated problems, is increasing every passing day. The use of screening tools to identify high-risk patients among elderly patients gains importance as it facilitates the selection of appropriate treatment and follow-up. In this study, we evaluate and compare the predictive ability of the Identification of Seniors at Risk (ISAR) and the Silver Code (SC) screening tools in Turkey.*

Materials and methods*: Patients aged 65-year and over who visited our ED over a ten-month period were enrolled. ISAR and SC tools were applied to participants following the initial medical assessment. Receiver operating characteristic (ROC) analysis was used to evaluate the predictive ability of the tools in short and long-term adverse outcomes such as ED re-visit, hospitalization, and mortality. These evaluations were performed following the initial ED visit, 1 and 6-month after the initial ED visit.*

Results*: The median (IQR) age of 497 participants was 73.0 (68.5, 79.0), and %53.9 were women. ISAR was slightly better than SC in predicting all adverse outcomes, except hospitalization following the initial visit, with poor-fair results [area under the ROC curves (AUCs) between 0.62-0.78]. SC was excellent in predicting hospitalization following the initial visit (AUC: 0.90) and poor in all other outcomes (AUCs between 0.58-0.71).*

Conclusion*: Although the results of our study underline that SC was excellent at predicting hospitalization following the initial ED visit, both tools were insufficient to make decisions for other adverse outcomes. Of course, this does not mean that the tools have no clinical value; but indicates that they are not suitable for clinical decision-making on their own and need improvements.*

Keywords: *Geriatric assessment, emergency department, screening.*

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Introduction

The proportion of the geriatric population is increasing every passing day. So, the number of elderly patients (aged 65 years and over) visiting the emergency departments (EDs) is increasing parallelly. In the literature, ED evaluation rates in elderly patients were reported between 12% and 21%, compared to total patients[1-3]. It was reported that geriatric patients visited the EDs more frequently and with more complicated problems than other patients.

They were subjected to additional radiological and laboratory procedures, stayed longer, and had a higher rate (32%-68%) of hospitalization than other age groups[1,4,5].

Being acquainted with the characteristics of the geriatric patients visiting the EDs can be helpful in guiding the accurate diagnosis and emergency treatment approaches[6]. Researches were made on screening tools for identifying high-risk patients among geriatric patients. The ones being the most frequently investigated and used were the "Identification of Seniors at Risk (ISAR)", "Silver Code

(SC)", and "Triage Risk Screening Tool". Studies on these scoring systems were conducted in Canada[7,8], Italy[2,9-12], Belgium[1,13], and other European countries[14,15].

In this study, our aim is to evaluate the ability of ISAR and SC to predict adverse outcomes such as ED re-visit, hospitalization, and mortality in elderly patients. And we also want to compare the predictive ability of ISAR and SC on these parameters. Thus, predicting the short and long-term adverse outcomes of geriatric patients will lead to the selection of more appropriate follow-up and treatments which can positively affect patients' prognosis. This may increase the quality of healthcare service provided and reduce costs.

Materials and methods

Study design and participants

The study was carried out as a single-centered, prospective, and observational study. Ethics committee approval was obtained from Istanbul Medipol University Non-Interventional Clinical Research Ethics Committee. The study was conducted in compliance with the ethical principles of the Helsinki Declaration.

Elderly (aged 65 and over) patients, who visited the Medipol Mega Hospital ED between December 21, 2015 and September 10, 2016 were determined as the target population. The ones who could be contacted by phone, who had a complete place-time orientation and cognitive functions, and who had relatives or caregivers being able to provide information were included in the study.

The patients who were brought to the ED with cardiopulmonary arrest, who did not wish to participate in the study, who were with a deteriorated place and time orientation and cognitive functions, and who did not have an attendant that could provide dependable information were excluded from the study.

Following the initial medical assessment; a 35-point questionnaire was administered to patients by the emergency medicine resident in charge, which included general socio-demographic information, ISAR, and SC tools.

Clinical follow-ups (discharge, death, etc.) of the patients who were hospitalized following the initial ED evaluation were obtained from the epicrisis reports.

The participants were followed for 6 months after the initial ED visit to assess the predictive ability of ISAR and SC for adverse outcomes such as ED revisit, hospitalization, and mortality. Regarding these parameters, 1st and 6th-month evaluations of the patients were conducted via telephone calls.

Measurements

The ISAR consisted of six yes/no questions that investigate functional status, previous hospital admission, presence of cognitive and visual impairments, and polypharmacy (use of 3+ drugs). Each "yes" was scored as 1 and "no" was scored as 0 points. The patients with a total score below 2 were considered as ISAR-negative, and 2 or above were considered as ISAR-positive[11].

The SC consisted of six variables; including age, gender, marital status, previous hospital admission, previous hospitalization, and polypharmacy (use of 8+ drugs); scored between 0 to 30[9]. In the SC screening tool, patients were divided into four risk classes with a score of 0 to 3 (Class-1), 4 to 6 (Class-2), 7 to 10 (Class-3), and 11+ (Class-4). As the score increases, the mortality and the morbidity risk of the patient increases.

Statistical Analysis

Statistical analyses were performed using SPSS 20.0 statistical package software. Normality was tested with the one-sample Kolmogorov-Smirnov test. Variables showing normal distribution were presented as mean and standard deviation. Variables that were not normally distributed were presented as the median and interquartile range (IQR). Chi-square test was used for statistical analysis. Receiver operating characteristic (ROC) analysis was used to evaluate the predictive power of the ISAR and SC tools identifying high-risk patients. A value of $p< 0.05$ was considered statistically significant.

Results

A total of 534 patients aged 65 years and over visited our ED. 497 of whom met the inclusion criteria, were included in the study. The median (IQR) age of the participants was 73.0 (68.5, 79.0) and 268 (53.9%) of them were women.

63 (12.7%) of 497 participants were hospitalized following the initial ED visit. In the first month follow-up, 357 (71.8%) participants were re-visited the ED, 120 (24.1%) were hospitalized and 14 (2.8%) died. Since those who died in the one-month period were excluded, the total number

of participants decreased to 483 in the sixth-month follow-up. 473 (97.9%) of them were re-visited the EDs, 202 (41.8%) were hospitalized and 46 (9.5%) died. The general findings of the participants were shown in Table 1.

Variables	Median (IQR) or n (%)
Age	73.0 (68.5, 79.0)
Female gender	268 (53.9)
Comorbid Diseases	
Any Comorbid Diseases	452 (90.9)
Diabetes	181 (36.4)
Hypertension	358 (72.0)
Coronary Artery Disease	171 (34.4)
Congestive Heart Failure	92 (18.5)
Chronic Renal Failure	26 (5.2)
Cerebrovascular Disease	36 (7.2)
Cancer	65 (13.1)
Other	136 (27.4)
SC	
Class-1 (0-3 points)	33 (6.6)
Class-2 (4-6 points)	47 (9.5)
Class-3 (7-10 points)	233 (46.9)
Class-4 (11+ points)	184 (37.0)
ISAR	
Negative (0-1 points)	172 (34.6)
Positive (2+ points)	325 (65.4)
Outcomes following the initial ED visit	
Immediate discharge	434 (87.3)
Hospitalization	63 (12.7)
Death	0 (0.0)
Outcomes of first-month follow-up	
ED Re-visit	357 (71.8)
Hospitalization	120 (24.1)
Death	14 (2.8)
Outcomes of sixth-month follow-up*	
ED Re-visit	473 (97.9)
Hospitalization	202 (41.8)
Death	46 (9.5)

Table 1: General characteristics of 497 participants.
SC, Silver code; ISAR, Identification of seniors at risk.
**This analysis was conducted on 483 patients since 14 patients died during the previous period*

When all participants were evaluated with the ISAR tool; it was determined that 172 (34.6%) of them were ISAR-negative and 325 (65.4%) were ISAR-positive. Following the initial ED visit, the participants who were hospitalized were 8 (4.7%) in ISAR-negative and 55 (16.9%) in the ISAR-positive group (p< 0.001) (Table 2).

	Number of Individuals n (%)	Immediate Discharge n (%)	p	Hospitalization n (%)	p	Death n (%)	p
SC							
Class-1	33 (6.6)	32 (97.0)	-	1 (3.0)	-	0 (0.0)	-
Class-2	47 (9.5)	47 (100)	0.230	0 (0.0)	0.230	0 (0.0)	-
Class-3	233 (46.9)	231 (99.1)	0.269	2 (0.9)	0.269	0 (0.0)	-
Class-4	184 (37.0)	124 (67.4)	<0.001**	60 (32.6)	<0.001**	0 (0.0)	-
ISAR			<0.001**		<0.001**		-
Negative	172 (34.6)	164 (95.3)		8 (4.7)		0 (0.0)	
Positive	325 (65.4)	270 (83.1)		55 (16.9)		0 (0.0)	

Table 2: The relationship between SC/ISAR and Discharge / Hospitalization / Death following the initial ED Visit§.
SC, Silver code; ISAR, Identification of seniors at risk.
The relationship between SC/ISAR and Discharge / Hospitalization / Death following the initial ED Visit

The ROC analysis revealed that the predictive ability of ISAR was poor-fair at this outcome [0.69±0.03 (95% CI, 0.620.76), (p< 0.001)]. In the first month follow-up, the participants who revisited the ED were 108 (62.8%) in ISAR-negative and 249 (76.6%) in the ISAR-positive group (p< 0.001). 27 (15.7%) of hospitalized participants were ISAR-negative and 93 (28.6%) were ISAR-positive (p< 0.001). In terms of mortality at a one-month period, 1 (0.6%) participant was ISAR-negative and 13 (4.0%) were ISAR-positive (p= 0.028) (Table 3).

	Number of Individuals n (%)	ED Re-visit n (%)	p	Hospitalization n (%)	p	Death n (%)	p
1. month							
SC							
Class-1	33 (6.6)	17 (51.5)	-	3 (9.1)	-	1 (3.0)	-
Class-2	47 (9.5)	35 (74.5)	0.034*	13 (27.7)	0.041*	0 (0.0)	0.230
Class-3	233 (46.9)	159 (68.2)	0.057	44 (18.9)	0.167	2 (0.9)	0.269
Class-4	184 (37.0)	146 (79.3)	<0.001**	60 (32.6)	0.006*	11(6.0)	0.495
ISAR			<0.001**		<0.001**		0.028*
Negative	172 (34.6)	108 (62.8)		27 (15.7)		1 (0.6)	
Positive	325 (65.4)	249 (76.6)		93 (28.6)		13 (4.0)	
6. month¥							
SC							
Class-1	32 (6.6)	30 (93.8)	-	14 (43.8)	-	1 (3.1)	-
Class-2	47 (9.7)	46 (97.9)	0.347	26 (55.3)	0.313	1 (2.1)	0.782
Class-3	231 (47.8)	225 (97.4)	0.259	103 (44.6)	0.929	20 (8.7)	0.279
Class-4	173 (35.8)	172 (99.4)	0.014*	59 (34.1)	0.295	24 (13.9)	0.088
ISAR			<0.001**		<0.001**		<0.001**
Negative	171 (35.4)	162 (97.4)		95 (55.6)		0 (0.0)	
Positive	312 (64.6)	311 (99.7)		107 (34.3)		46 (14.7)	

Table 3: The relationship between SC/ISAR and ED Re-visit / Hospitalization / Death in the first and sixth month after the initial ED Visit§.
SC, Silver code; ISAR, Identification of seniors at risk.
***p<.01, *p<.05. §: ISAR-negative and ISAR-positive groups were compared with each other and SC class-1 was compared with SC class-2, SC class-3, and SC class-4. ¥: This analysis was conducted on 483 patients since 14 patients died during the previous period.*

The differences in first-month outcomes among ISAR groups were clinically significant and the most significant difference was in the mortality endpoint. The mortality rate was raised 6.6-fold among ISAR groups (0.6% in ISAR-negative,

4.0% in ISAR-positive). The ROC analyses were conducted for the first-month outcomes. Predictive ability of ISAR was poor at ED re-visit [0.62±0.03 (95% CI 0.56-0.67) (p< 0.001)] and hospitalization [0.62±0.03 (95% CI 0.56-0.68) (p< 0.001)] endpoints and poor-fair at mortality endpoint [0.70±0.06 (95% CI 0.58–0.82) (p= 0.011)]. The sixth-month follow-up was performed over 483 participants by excluding the 14 of whom died in a one-month period. 162 (97.4%) of ISAR-negative and 311 (99.7%) of ISAR-positive participants were revisited EDs (p< 0.001). 95 (55.6%) ISAR-negative and 107 (34.3%) ISAR-positive participants were hospitalized (p< 0.001). At the sixth month follow-up, there was no clinically significant difference between the ISAR groups in ED re-visit and hospitalization endpoints. But, in terms of mortality, all 46 participants were ISAR positive (14.7%, p< 0.001) (Table 3). The ROC analysis revealed that ISAR was fair in predicting ED re-visit [0.78±0.04 (95% CI 0.70–0.86), (p=0.002)] and mortality at 6-month [0.69±0.03 (%95 CI 0.63–0.75) (p< 0.001)].

When all these evaluations were carried out with SC tool; it was determined that 33 (6.6%) of the participants were in SC class-1, 47 (9.5%) were in SC class-2, 233 (46.9%) were in SC class-3 and 184 (37.0%) were in SC class-4. Following the initial ED visit, the distribution of hospitalized participants was 1 (3.0%), 0 (0.0%), 2 (0.9%) and 60 (32.6%) across SC classes (p= 0.230, 0.269, <0.001; respectively) (Table 2). Prognostic performance of SC at this outcome was excellent, as indicated by values of the area under the ROC curve [0.90±0.02 (95% CI, 0.85–0.94), (p< 0.001)]. The corresponding figures for the first-month outcomes were 17 (51.5%), 35 (74.5%), 159 (68.2%) and 146 (79.3%) for ED re-visit (p= 0.034, 0.057, <0.001; respectively); 3 (9.1%), 13 (27.7%), 44 (18.9%) and 60 (32.6%) for hospitalization (p= 0.041, 0.167, 0.006; respectively); and 1 (3.0%), 0 (0.0%), 2 (0.9%) and 11 (6.0%) for mortality, across SC classes (p> 0.05 for all) (Table 3). Clinically and statistically, there were no significant differences among SC classes in terms of first-month outcomes. The results of ROC analyses for these first-month outcomes were poor as follows; ED re-visit [0.58±0.03 (95% CI 0.53-0.64), (p= 0.003)], hospitalization [0.59±0.03 (95% CI 0.53-0.65), (p= 0.005)] and mortality [0.62±0.07 (95% CI 0.49-0.76), (p= 0.123)]. In the 6-month follow-up of 483 participants; 30 (93.8%) from class-1, 46 (97.9%) from class-2, 225 (97.4%) from class-3, and 172 (99.4%) from class-4 participants revisited the EDs (p= 0.347, 0.259, 0.014; respectively). From low to high, the SC tool identified the hospitalized participants as 14 (43.8%), 26 (55.3%), 103 (44.6%) and 59 (34.1%), respectively (p> 0.05). SC could not detect clinically significant differences between risk classes in terms of ED re-visit and hospitalization at the sixth-month follow-up, as ISAR. Participants who died in this period according to SC risk classes were 1 (3.1%), 1 (2.1%), 20 (8.7%) and 24 (13.9%), respectively (p> 0.05) (Table 3). By the sixth month outcomes, the ROC analysis indicated that predictive ability of SC was poor-fair in ED re-visit [0.71±0.07 (95% CI 0.57–0.85), (p= 0.024)], and poor in mortality [SC 0.61±0.04 (%95 CI 0.53–0.69) (p= 0.014)].

The correlation between ISAR and SC screening tools was weak (r = 0.338), (p <0.001). The proportion of ISAR positive participants progressively increased in SC risk classes, as expected (30.3%, 40.4%, 61.4% and 83.2%; p<0.001, <0.001, <0.077, <0.001; respectively). The median (IQR) SC score of the ISAR-positive patients was 10.0 (8.0, 13.0), and 153 of them (47.0%) scored 11+ points, which corresponded the highest risk class for SC (p< 0.001).

ROC analyses were performed to compare the predictive ability of ISAR and SC in short and long-term outcomes. SC was more successful compared to ISAR in hospitalization following the initial ED visit (0.90-0.69) (Fig. 1).

ISAR was slightly better than SC in predicting all the three first-month outcomes. The overall prognostic performances of the two tools were poor for the ED re-visit (0.58-0.62) and hospitalization endpoints (0.59-0.62); and poor-fair for the mortality endpoint (0.62-0.70) (Fig. 2, Fig. 3, and Fig.

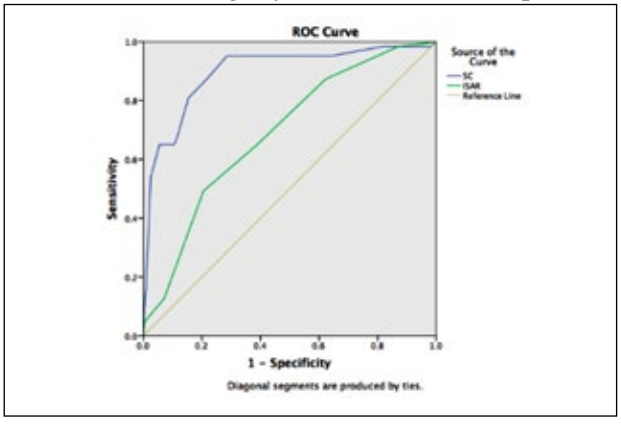

Figure 1: SC / ISAR - ROC curve of hospitalization following the initial ED visit.
SC 0.90±0.02 (95% CI, 0.85–0.94), ISAR 0.69±0.03 (95% CI, 0.62–0.76), (p<0.001 for all)

4). As a predictor for the sixth-month outcomes, SC was poor-fair and ISAR was fair in ED re-visit (0.71-0.78). SC was poor and ISAR was poor-fair in mortality (0.62-0.72), and again ISAR was more successful compared to SC (Fig. 5 and Fig. 6).

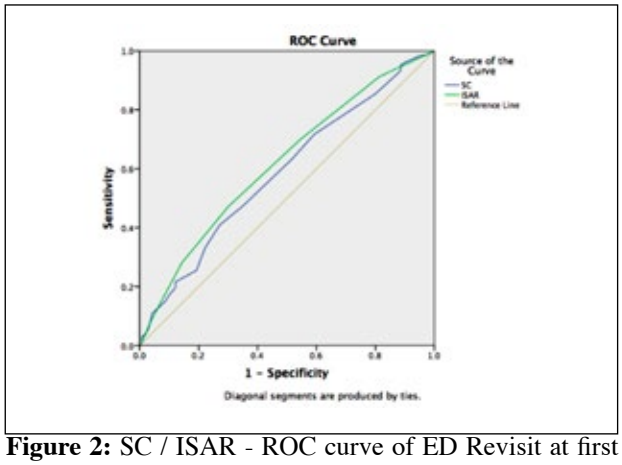

Figure 2: SC / ISAR - ROC curve of ED Revisit at first month.
SC 0.58±0.03 (95% CI 0.53–0.64), ISAR 0.62±0.03 (95% CI 0.56–0.67), (p= 0.003 for SC and p<0.001 for ISAR)

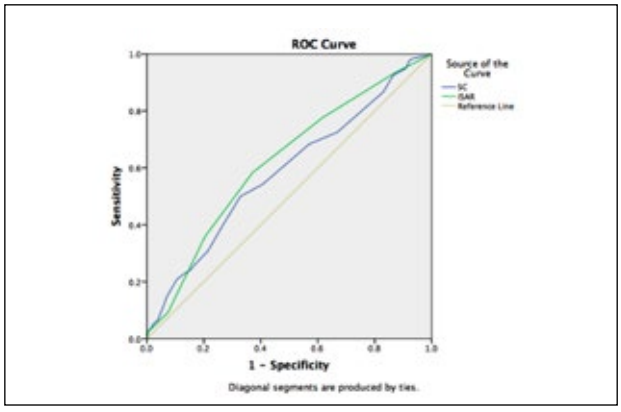

Figure 3: SC / ISAR - ROC curve of hospitalization at first month.
SC 0.59±0.03 (95% CI 0.53–0.65), ISAR 0.62±0.03 (95% CI 0.56–0.68), (p= 0.005 for SC and p<0.001 for ISAR)

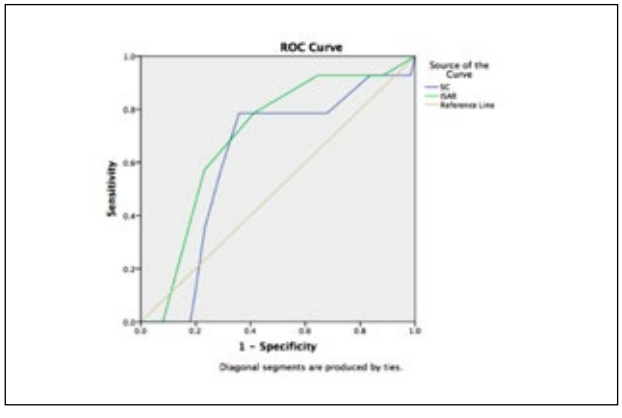

Figure 4: SSC / ISAR - ROC curve of mortality at first month.
SC 0.62±0.07 (95% CI 0.49–0.76), ISAR 0.70±0.06 (95% CI 0.58–0.82), (p= 0.123 for SC, and 0.011 for ISAR)

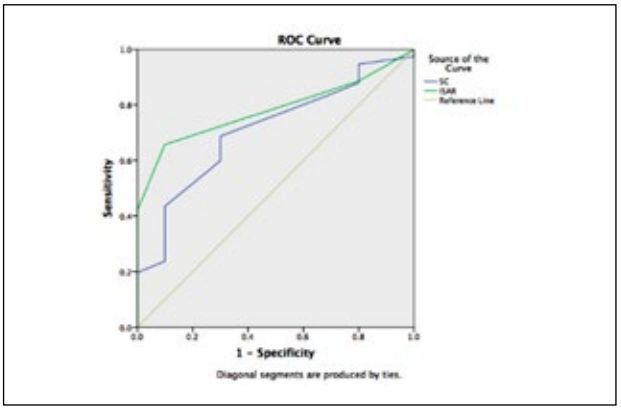

Figure 5: SC / ISAR - ROC curve of ED revisit at sixth month.
SC 0.71±0.07 (95% CI 0.57–0.85), ISAR 0.78±0.04 (95% CI 0.70–0.86), (p= 0.024 for SC, and 0.002 for ISAR)

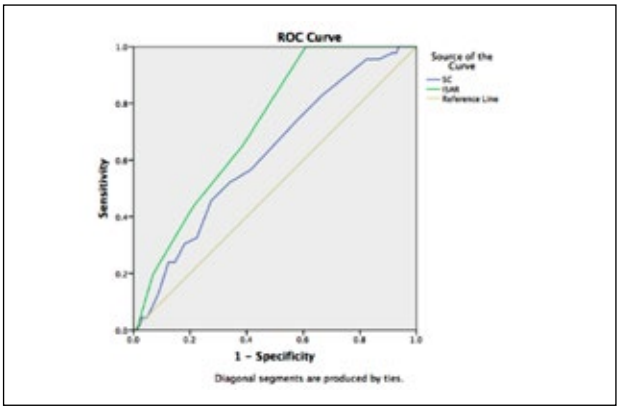

Figure 6: SC / ISAR - ROC curve of mortality at sixth month.
SC 0.62±0.04 (%95 CI 0.54–0.70), ISAR 0.72±0.03 (%95 CI 0.66–0.78), (p= 0.007 for SC and p<0.001 for ISAR)

Discussion

The purpose of this study was to investigate the predictive ability of ISAR and SC screening tools to detect adverse outcomes after discharge from ED among patients older than 65 years. Therefore, elderly patients were evaluated in terms of hospitalization following the initial ED visit; and ED re-visit, hospitalization, and death in 1 and 6-month after the initial ED visit. To the best of our knowledge, this is the first study that evaluates ISAR and SC tools together in Turkey.

In our sample, hospitalization following the initial ED visit was excellently predicted by SC (AUC: 0.90), and poor-fair by ISAR (AUC: 0.69). In the first-month follow-up; ISAR predicted re-visit, hospitalization, and mortality at the poor-fair level (AUCs 0.62, 0.62, 0.70; respectively), while SC predicted ED re-visit and hospitalization at a poor level (AUCs 0.58 and 0.59, respectively). SC was statistically insignificant in predicting mortality in

the first month. In the sixth month, the predictive ability of ISAR was fair in ED re-visit and poor-fair in mortality (AUCs 0.78, 0.72; respectively), and SC was poor-fair in ED re-visit and poor in mortality (AUCs 0.71, 0.62, respectively). ISAR and SC were statistically insignificant to predict hospitalization at 6-month. Although there was a weak correlation between ISAR and SC, ISAR was slightly more successful in predicting all short and long-term adverse outcomes, except hospitalization following the initial ED visit.

Our results were consistent with previous researches testing the ISAR tool, despite being in different circumstances. In a number of studies, the ISAR predicted adverse outcomes (including ED re-visits, hospitalization, and death) in the 1 to 6 months after discharge from the ED but always with poor predictive validity (AUCs between 0.60-0.72)[7,8,11,12,14,16]. In a Belgian study comparing three screening tools, worse results were found for ISAR at 30 and 90-day ED re-visit (AUCs 0.49, 0.52; respectively)[13].

There were very few studies in the literature for the SC tool. In the study of elderly Italians, the SC tool showed poor comparable predictive value for adverse outcomes following initial ED visit and 6-month (AUCs 0.58, 0.70; respectively)[2]. The salient finding for SC in our study was that the SC tool was excellent for predicting hospitalization following the initial ED visit. Di Bari et al. defined the patients who were taken to the emergency observation room, inpatient ward, and/or intensive care unit as hospitalized. The expansion of the hospitalized participants sample in that study with including less risky patients, who followed in the observation room, may have impaired the predictive ability of the SC tool in this outcome. On the other hand, age data directly affects the SC score. The lower age limit was 65 in our study and 75 in the study of Di Bari et al., and this affected the average age of the samples (73.0, 84.0; respectively). This 10-year difference may have made patients more vulnerable and fragile in terms of disease susceptibility, comorbidity, and mortality. However, in terms of short and long-term adverse outcomes, the predictive ability of the SC was slightly better in our study compared to the study of Di Bari et al.

A risk tool to be used in the ED should be quick, informative, reliable, and inexpensive[15]. SC is based on demographics, resource utilization, and diagnostics with detailed scorings. It is difficult to calculate and use; and it also does not incorporate aspects of geriatric assessment. ISAR combines demographics with basic clinical evaluation and resource utilization with six yes/no questions. It can be easily evaluated by almost any trained professional. We observed that the ISAR tool was easily applied to elderly patients in the ED. Although ISAR is one step ahead among the studies in the literature, it is still seen that the suggestions for the search for a good and reliable tool in the short and long term[17-19].

We conducted our research in a foundation university hospital and in a single-center. Compared to similar studies in the literature, we had fewer patients. Outpatients who applied to our ED were directed to the relevant outpatient departments of the hospital between 9:00 a.m. and 12:00 a.m.; these patients, who could not be evaluated in ED, were not included in the study. This prevented the number of patients from increasing.

In conclusion, ISAR had poor-fair and SC had poor predictions in adverse outcomes (except SC's hospitalization prediction following the initial ED visit). In our sample, SC's success in predicting hospitalization was seen as promising for its clinical use, if supported by studies with large samples. Selecting patients at risk for hospitalization will reduce the burden for the patient and the system, as it will contribute to preventing unexpected deterioration and reducing recurrent ED visits. Obviously, our findings suggest that both tools are insufficient to make decisions for short and long-term adverse outcomes in patients over 65-year. Of course, this does not mean that the tools have no clinical value; but indicates that they are not suitable for clinical decision-making on their own. They can be used as ancillary tools, combined with clinical experience. Overall, the evidence on tools to support the identification and management of high-risk elderly patients in the ED is extensive but appears to be inconclusive[17]. The different and contradictory results obtained from the studies using the same tools show that the differences between countries and geographical regions are effective in adverse outcomes. For example, ED re-visit rates of patients in Turkey are higher compared to studies in other countries. Because EDs provide the opportunity of easy access, quick evaluation, and diagnosis here. Also, due to differences in living conditions, life expectancy and quality will vary in different countries, which will affect morbidity and mortality. Therefore, a study in one country cannot be easily generalized to other countries.

It's clear that an adequate tool has not yet been designed to appropriately assess high-risk elderly patients in EDs, and there is a need for studies and tools that cover all these issues to fill this gap.

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