Journal of Gerontology: MEDICAL SCIENCES
Cite journal as: J Gerontol A Biol Sci Med Sci. 2012 May;67A(5):544–550
doi:10.1093/gerona/glr209

Advance Access published on December 7, 2011

Prognostic Stratification of Elderly Patients in the Emergency Department: A Comparison Between the "Identification of Seniors at Risk" and the "Silver Code"

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Background. The increasing number of elderly patients accessing emergency departments (EDs) requires use of validated assessment tools. We compared the Identification of Seniors at Risk (ISAR), using direct patient evaluation, with the Silver Code (SC), based on administrative data.

Methods. Subjects aged 75+ years accessing a geriatric ED over an 8-month period were enrolled. Outcomes were need for hospital admission and mortality at the index ED access, ED return visit, hospitalization, and death at 6 months.

Results. Of 1,632 participants (mean age 84 ± 5.5 years), 75% were ISAR positive, and the sample was homogeneously distributed across the four SC risk categories (cutoffs of 0–3, 4–6, 7–10, and 11+). The two scores were mildly correlated ($r = .350$, $p < .001$) and had a similar area under the receiver-operating characteristic curve in predicting hospital admission (ISAR: 0.65, SC: 0.63) and mortality (ISAR: 0.72, SC: 0.70). ISAR-positive subjects were at greater risk of hospitalization and death (odds ratio 2.68 and 5.23, respectively, $p < .001$); the risk increased across SC classes ($p < .001$). In the 6-month follow-up of discharged patients, the tools predicted similarly ED return visit, hospital admission, and mortality. The SC predicted these outcomes even in participants not hospitalized at the index ED access.

Conclusions. Prognostic stratification of elderly ED patients with the SC is comparable with that obtained with direct patient evaluation. The SC, previously validated in hospitalized patients, predicts ED readmissions and future hospitalizations even in patients discharged directly from the ED.

Key Words: Emergency department—Risk stratification—Administrative databases—Prognostic stratification.

Received July 18, 2011; Accepted October 16, 2011

Decision Editor: Luigi Ferrucci, MD, PhD

IN the last few years, emergency departments (EDs) in many countries have faced a continuous increase in both the absolute numbers of visits and rate of visits per unit population (1). As shown in several studies, persons above the age of 65 years are largely responsible for this trend: In the United States, ED visits of older persons account for about 18% (range 11%–23%) of all visits and increased by 26% from 1993 to 2003 (2). This is to be expected, given the high prevalence in an aging population of chronic diseases that, with their recurrent exacerbations, make old persons frequent users of the ED. Similar trends have been reported in Italy, with the share of older persons, among patients requiring ED visits, increasing from 17.7% in 2000 to 21.4% in 2008 (3,4).

Older adults use the ED for more urgent problems (5), require more tests and consume more resources, stay longer, and are more frequently admitted to the hospital (30%–50% vs 12%) compared with younger patients (6). They are at greater risk of ED revisits, hospitalization, institutionalization, functional decline, and death after an ED access (6). In elderly patients, an ED visit is often a sentinel event for declining health status that should prompt appropriate assessment and care, and interventions via the emergency system have significant opportunities to change the clinical course of older patients who require these services (7).

Unfortunately, ED represents a challenging environment for optimal geriatric care, and time constraints and intense workflow limit the possibility to identify, among older

persons seeking care in the ED, those at high risk, to be referred to second-level evaluation and specialized management. Of the few quick and easy-to-administer screening tests that have been proven to identify high-risk patients during an ED visit, the Identification of Seniors at Risk (ISAR) is a questionnaire developed and validated in Canada (8) and successfully used in Belgium (9) and Italy (10). A positive test (score of ≥2 in a range from 0 to 6) suggests an increased risk of undergoing adverse events, such as death, institutionalization, functional decline, repeated ED visits, and hospital admissions within 6 months.

More recently, the Silver Code (SC), a prognostic tool based solely on administrative data, was developed and validated in a large nonconcurrent cohort study of patients aged 75+ years, admitted for medical reasons to hospitals in the area of Florence, Italy (11). With the SC, a score is assigned to age, sex, marital status, admission to a day hospital, admission to regular ward with corresponding discharge diagnosis, and polypharmacy, 3–6 months prior to the index ED visit. In the original study (11), 1-year mortality increased linearly with the SC score: Compared with a score of 0–3, the risk of death was 1.5, 2.2, and 3.0 times greater for scores of 4–6, 7–10, and 11+, with p values between contiguous strata always highly significant. A score of 11+ identified patients whose long-term mortality rate was significantly lower if they were admitted to an acute geriatrics unit rather than to an internal medicine ward.

So far, the SC has not been compared with instruments describing health status at presentation to the ED, nor was its validity tested in patients discharged directly from the ED. Moreover, although the original sample was split into a development and a validation subsample, the external validity of the tool was unknown. Should the SC be proven valid in different populations, compare well with tools requiring direct patient contact, and be deployed in real time instead of being calculated retrospectively, it might provide an initial rapid prognostic stratification of older persons in the ED. Therefore, aims of the present study were as follows: (a) to compare the SC to the ISAR, a tool based on direct clinical evaluation, (b) to validate the SC in patients leaving the ED without being hospitalized, and (c) to test its external validity in a population different from that where it had been developed.

Methods

This is a cohort study conducted at the Geriatric Department of the National Institute of Health and Science on Aging Hospital in Ancona, Italy. This Department has an ED dedicated to geriatric patients (12), with a short-stay Observation Unit where patients who cannot be discharged directly can be observed for up to 24–48 hours.

Participants were all residents in the Marche region, aged 75+ years, prospectively accessing the National Institute of Health and Science on Aging Hospital ED between January and June 2009, with the exclusion of those unable to provide reliable information and consent and lacking a caregiver. Traumatic injury was not an explicit exclusion criterion; however, patients with major trauma are directly admitted to other hospitals in the Ancona area. Patients who were either eventually admitted to the hospital or discharged directly from the ED were enrolled. In the case of repeated ED visits in the enrollment period, the first one was considered as the index visit. The study protocol was approved by the National Institute of Health and Science on Aging Ethics Committee.

Of 3,197 patients aged 75+ years presenting to the ED in the study period, 336 (11%) were excluded because of nighttime arrival (from 10 PM to 6 AM), when there was no study staff to administer the ISAR; 1,067 (33%) were repeated ED visits; and 162 (5%) refused or were unable to participate because of cognitive impairment and lack of a caregiver. The final sample included 1,632 participants.

A validated Italian version of the ISAR (10) was administered by a skilled nurse at triage, soon after the level of severity had been evaluated with the usual color-coding system. The ISAR is composed of six yes/no items that concisely investigate functional status, previous hospital admission, presence of cognitive and visual impairments, and polypharmacy (use of 3+ drugs). The summary score (range 0–6), as well as the cutoff of ≥2, was considered for analysis. Staff responsible for participants' clinical management remained blinded to the results of the ISAR, which, therefore, could not influence any of the outcomes.

To obtain the SC, data were retrospectively, months after the index ED access, extracted from the administrative archives that every Italian region maintains for managing its health care system. Information on demographics, hospitalizations,

Table 1. Scores Assigned to Silver Code Variables

Variable	Score
Age (y)	
75–79	0
80–84	3
85+	9
Sex	
Female	0
Male	2
Marital status	
Married	0
Unmarried/widowed/divorced	1
Previous admission to a day hospital	
No	0
Yes	5
Previous admission to a regular ward and discharge diagnosis	
No admission	0
Respiratory disease	6
Cancer	11
Other	2
Number of drugs in the previous 3 mo	
0–8	0
8+	2

Table 2. General Characteristics of 1,632 Admissions to the ED

	M ± *SEM* or *n* (%)
Age (y)	84 ± 5.5
Female gender	990 (61)
Positive to the ISAR	1,222 (75)
SC risk class	
0–3	305 (19)
4–6	401 (25)
7–10	447 (27)
11+	479 (29)
Outcome after ED visit	
Immediate discharge	888 (54)
Temporary admission to the Observation Unit	167 (10)
Hospital admission	558 (34)
Death in the ED	19 (1.2)
Outcome after Observation Unit or hospital admission	
Discharge	650 (90)*
Death	75 (10)*
ED return visit in 6 mo	669 (44)†
Hospital admission in 6 mo	527 (34)†
Death in 6 mo	239 (16)†

Notes: ED = emergency department; ISAR = Identification of Seniors at Risk; SC = Silver Code.

*Proportions calculated using as a denominator the number of 725 participants admitted to either the Observation Unit (n = 167) or a hospital regular ward after the index ED visit.

†Proportions calculated using as a denominator the number of 1,538 participants discharged alive either immediately after the index ED visit (n = 888) or after admission to the Observation Unit or a regular ward (n = 650).

drug prescriptions, and deaths were retrieved using automated data linkage procedures, based on the participant's identification number or fiscal code as unique identifiers; linkage was 100% complete. A simple set of demographic and clinical characteristics, previously shown to be multivariable predictors of 1-year mortality (11), were assigned a score (Table 1), from which the SC was calculated by summation. Both the continuous SC score and four classes of increasing risk score (0–3, 4–6, 7–10, and 11+) were considered.

Outcome measures were time spent in the ED, need for hospitalization at the end of the index ED access, and hospital mortality at baseline. Return visits to the ED and hospital admissions, limited to facilities of the Marche region, and mortality were considered in a 6-month follow-up.

Data were analyzed with the SPSS for Windows, version 18, statistical package. Continuous variables are presented as mean ± standard error of the mean and categorical variables as relative frequencies. Pearson's r test was used to analyze the correlation between ISAR and SC scores. The χ^2 test was used to compare relative frequencies, with linear trends when appropriate. One-way analysis of variance was used to compare means, with polynomial contrasts to evaluate linear trends when appropriate.

The predictive accuracy of the ISAR and the SC for hospital admission and hospital death in the index ED visit was assessed by calculating the area under the receiver-operating characteristic (ROC) curve, where the two scores were entered separately as continuous variables; the curves were compared by taking into account the overlap of their 95% confidence intervals. Hospital admission and hospital mortality were also analyzed in logistic regression models, where ISAR scores below and above the threshold of 2, as well as SC scores of 0–3, 4–6, 7–10, and 11+, were entered as separate categorical variables. To the purpose of primary data analysis, admissions to the Observation Unit were considered as hospital admission. Additional analyses were performed after exclusion of cases admitted to the Observation Unit before discharge.

ROC curves were used to evaluate the ability of the two tools to predict return ED visits, hospital admissions, and mortality in a 6-month follow-up. These outcomes were also analyzed in Cox proportional hazards models, where the ISAR and the SC categorical variables were individually entered as predictors. The assumption of proportionality was checked with visual inspection of the survival curves.

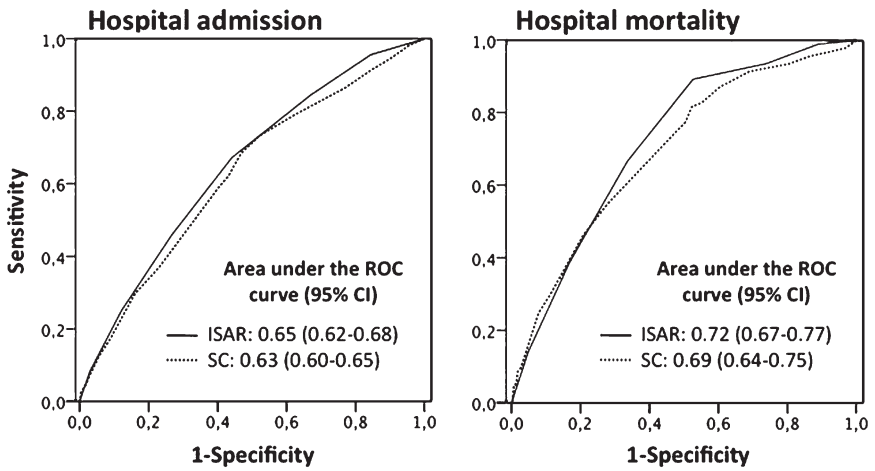

Figure 1. Receiver-operating characteristic (ROC) curves, with area under the curve and 95% confidence interval (CI), of the Identification of Seniors at Risk (ISAR) and the Silver Code (SC) in the prediction of hospital admission (left panel) and hospital mortality (right panel).

Further analyses on the same outcomes were performed by considering only participants who were discharged directly from the ED.

A two-tailed p value less than .05 was considered statistically significant.

Results

A total of 1,632 participants (women 61%; mean age 84 years, range 75–103) were recruited (Table 2). The ISAR was positive in the majority of the sample; the distribution into the four risk classes of the SC was homogeneous. The outcome of the index ED admission by ISAR and SC is described in detail in Supplementary Appendix Table A1. Overall, 888 participants were discharged directly from the ED, 167 were admitted to the Observation Unit and then discharged, and 558 were admitted to the hospital. Ninety-four participants died in the hospital (5.8% of the total sample), of whom 19 died in the ED.

The correlation between ISAR and SC scores was fair (r = .350), though highly statistically significant (p < .001). As expected, the proportion of ISAR-positive participants increased progressively across SC risk classes 0–3, 4–6, 7–10, and 11+ (55%, 67%, 81%, and 88%, respectively; p for trend < .001).

The time spent in the ED was significantly greater in ISAR-positive (465 ± 20 minutes) than in ISAR-negative participants (283 ± 16 minutes) and increased progressively across SC classes, from 340 ± 38 minutes in class 0–3 to 537 ± 35 minutes in class 11+ (p for trend < .001). The proportion of participants who were admitted to either the Observation Unit or a regular hospital ward was 28% in ISAR-negative and 51% in ISAR-positive participants (p < .001) and 33%, 33%, 53%, and 57% across SC classes (p for trend < .001). The corresponding figures for hospital mortality (which included deaths occurring either in the ED or after hospitalization) were 1.5% and 7.2% (p < .001) when participants were classified with the ISAR and 2.0%, 2.5%, 6.0%, and 11% (p < .001) across SC classes. Overall prognostic performance of the two tools was satisfactory, as indicated by values of the area under the ROC curve between 0.63 and 0.72, and only slightly nonsignificantly worse for the SC than for the ISAR (Figure 1). Details of the prognostic performance of the two tools, by each cutoff point and in respect to both short-term outcomes, are reported in the Supplementary Appendix Tables A2 and A3.

ISAR-positive participants had an odds ratio of 2.68 (95% confidence interval 2.10–3.42) for hospital admission and of 5.23 (2.27–12.04) for death (p < .001 in both comparisons). Compared with participants who scored 0–3, the risk of hospitalization increased progressively across SC classes, with odds ratio of 1.03 (0.75–1.41), 2.27 (1.68–3.08), and 2.76 (2.05–3.73; p for trend < .001). The risk of death showed an even steeper increase, as indicated by odds ratio of 1.28 (0.46–3.55), 3.20 (1.31–7.86), and 5.94 (2.52–14.02;

Table 3. Number of Events, Person-years of Exposure, Crude Rates, and Risk of Return Visit, Hospital Admission, and Death in a 6-Month Follow-up After the Index Emergency Department Access in the Entire Sample of 1,632 Participants

	Return Visit					Hospital Admission					Death				
	No. of Events	P-Y	Rate, per 1,000 P-Y	HR (95% CI)	p	No. of Events	P-Y	Rate, per 1,000 P-Y	HR (95% CI)	p	No. of Events	P-Y	Rate, per 1,000 P-Y	HR (95% CI)	p
Model 1															
ISAR					<.001					<.001					<.001
0–1	135	155	872	Ref.		108	162	668	Ref.		22	194	114	Ref.	
2+	534	354	1,509	1.66 (1.38–2.00)		419	410	1,022	1.50 (1.22–1.86)		217	496	438	3.81 (2.45–5.90)	
Model 2															
SC					<.001*					<.001*					<.001*
0–3	106	112	946	Ref.	—	76	121	630	Ref.		13	144	90	Ref.	—
4–6	150	141	1,066	1.12 (0.87–1.43)	.381	121	151	802	1.26 (0.95–1.68)	.113	34	183	186	2.05 (1.08–3.89)	.028
7–10	178	145	1,227	1.27 (1.002–1.62)	.048	144	160	903	1.42 (1.07–1.87)	.014	76	186	408	4.46 (2.48–8.03)	<.001
11+	235	111	2,120	2.08 (1.65–2.62)	<.001	186	141	1,323	2.03 (1.55–2.65)	<.001	116	176	659	7.17 (4.04–12.7)	<.001

Notes: Separate Cox proportional hazard models including either the ISAR (model 1) or the SC (model 2) as the explanatory variable. CI = confidence interval; HR = hazard ratio; ISAR = Identification of Seniors at Risk; P-Y = person-years; SC = Silver Code.
*p for trend.

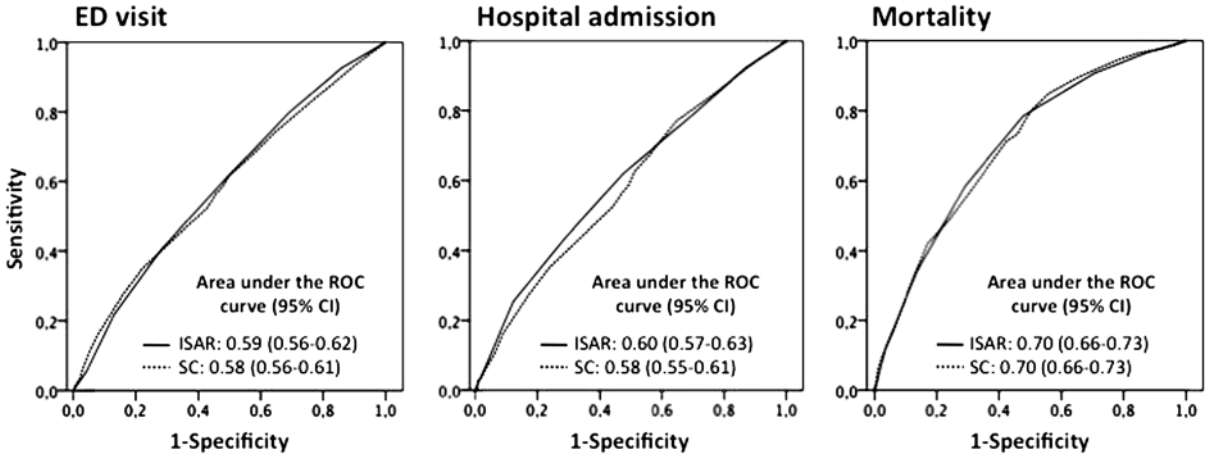

Figure 2. Receiver-operating characteristic (ROC) curves, with area under the curve and 95% confidence interval (CI), of the Identification of Seniors at Risk (ISAR) and the Silver Code (SC) in the prediction of emergency department (ED) return visit (left panel), hospital admission (central panel), and mortality (right panel) in a 6-month follow-up of the 1,538 participants discharged alive after the index ED visit.

p for trend < .001). All these results remained substantially unaffected by exclusion of participants who were discharged from the ED after Observation Unit stay.

Of the 1,538 participants discharged alive, including those who had been admitted to the hospital after the index ED visit, 135 (33%) ISAR-negative and 534 (47%) ISAR-positive patients had a return ED visit, 108 (27%) and 419 (37%) required hospitalization, whereas 22 (5.4%) and 217 (19%) died in the 6-month follow-up ($p < .001$ in all comparisons). Across SC classes, these percentages were 36%, 38%, 42%, and 55% for return ED visit, 25%, 31%, 34%, and 44% for hospital admission, and 4.3%, 8.7%, 18%, and 27% for mortality (*p* for trend < .001 for all comparisons).

In separate Cox regression models on the entire sample (Table 3), both a positive ISAR score and an SC risk class higher than 0–3 predicted a return visit to the ED, hospitalization, and death in the 6-month follow-up. ROC curves suggested that the overall prognostic performance of the two tools was good for the mortality end point, with areas under the ROC curve of 0.70 for both ISAR and SC, and suboptimal for the other two end points (areas under the ROC curve between 0.58 and 0.60), again with no significant difference between the SC and the ISAR (Figure 2).

When analyses were restricted to the 888 participants who had not been admitted to the hospital at the index ED access, the SC predicted all three follow-up outcomes, whereas the ISAR was associated with return visit and death but not with hospitalization (Table 4). The area under the ROC curve was comparable between the ISAR and the SC for the three outcomes (data not shown).

Discussion

In this study, the SC correlated well with the ISAR and proved to be at least as accurate in predicting time spent in the ED; need for hospitalization and hospital mortality after the index ED visit; and long-term outcomes, such as ED return visit, hospitalization, and death in 6 months. The predictive ability of the SC was maintained in participants who left the ED at the end of the index visit without being hospitalized.

These findings confirm and expand in a different population the results of a previous study (11), in which the SC was developed and validated in patients admitted to the hospital, with 1-year mortality as the only outcome. Thus, the external validity of the SC, its comparability with an established tool for direct clinical assessment of older patients in the ED, and its ability to predict a variety of relevant outcomes besides mortality are now all well documented, even in patients discharged directly from the ED. The SC proves to be a solid prognostic predictor in older patients accessing the ED for medical reasons.

Given that an ED visit by an older person typically heralds high risk for decline and death, the ED may represent a crucial care site for older persons, where ideally interventions able to change patients' health trajectories can be delivered (7). In this context, the utility of valid, rapid, and low-cost instruments for the early identification of older persons with complex medical problems and poor prognosis, among those who seek medical care in the ED, cannot be overemphasized. Evidence has been provided that, compared with traditional internal medicine wards, acute geriatrics units, where comprehensive assessment and tailored therapeutic programs are applied, improve survival and functional outcomes of frail older patients (13–15). This implies that health care professionals, who are increasingly required to optimize resource utilization, must perform a careful prognostic stratification. The ISAR is one of the few instruments (9,16) specifically designed to evaluate older patients and assess their prognosis in the ED. Our findings confirm its validity in respect to several outcomes and show

Table 4. Number of Events, Person-years of Exposure, Crude Rates, and Risk of Return Visit, Hospital Admission, and Death in a 6-Month Follow-up After the Index ED Access in the 888 Participants Not Admitted to the Hospital at the Index ED Visit

	Return Visit					Hospital Admission					Death				
	No. of Events	P-Y	Rate, per 1,000 P-Y	HR (95% CI)	*p*	No. of Events	P-Y	Rate, per 1,000 P-Y	HR (95% CI)	*p*	No. of Events	P-Y	Rate, per 1,000 P-Y	HR (95% CI)	*p*
Model 1															
ISAR					<.001					.163					<.001
0–1	97	114	853	Ref.		72	121	594	Ref.		9	142	63	Ref.	
2+	275	194	1,419	1.61 (1.27–2.02)		171	236	726	1.22 (0.92–1.60)		62	275	226	3.54 (1.76–7.12)	
Model 2															
SC					<.001*					<.001*					<.001*
0–3	69	78	882	Ref.	—	40	88	457	Ref.	—	3	100	30	Ref.	—
4–6	107	96	1,109	1.24 (0.92–1.68)	.159	77	107	721	1.56 (1.07–2.29)	.022	16	127	126	4.18 (1.22–14.33)	.023
7–10	79	80	994	1.13 (0.82–1.56)	.468	48	91	526	1.15 (0.76–1.75)	.516	13	101	129	4.29 (1.22–15.05)	.023
11+	117	53	2,189	2.30 (1.70–3.09)	<.001	78	71	1,096	2.33 (1.59–3.42)	<.001	39	89	440	14.50 (4.48–46.92)	<.001

Notes: Separate Cox proportional hazard models including either the ISAR (model 1) or the SC (model 2) as the explanatory variable. CI = confidence interval; ED = emergency department; HR = hazard ratio; ISAR = Identification of Seniors at Risk; P-Y: person-years; SC = Silver Code.

* *p* for trend.

that it predicts need for hospital admission and hospital mortality, findings that had never been reported previously. However, it should be pointed out that at the usual cutoff of ≥2, the tool classified as at risk most of the participants in this study, when in fact less than half of them were eventually hospitalized and approximately 6% died in the hospital. These findings are in agreement with those from previous studies, where the poor specificity of the ISAR was criticized and the suggestion was made to increase to 6 the cutoff point of the polypharmacy item (17). On the other hand, the SC, with its four classes, appears to offer a more articulated assessment, culminating in the substantially greater risk for hospital admission and death in the acute phase, as well as for new events in the follow-up, in the 11+ class. In the long term, both tools performed well for mortality but poorly for return visits and rehospitalizations. This is not surprising for the SC, which was indeed developed using long-term mortality as an outcome, yet is somewhat disappointing for the ISAR, which had been reported to be a valid predictor of return visits and rehospitalizations in previous studies (8,18). It is possible that differences in health care systems and, in particular, in community services account for these differences in the performance of the ISAR across studies.

To our knowledge, the SC is the first tool predicting prognosis of older hospitalized patients based purely on administrative data, which would be virtually available even before patients access the ED. Because it does not take into account the reason for the index ED access, its prognostic ability reflects patient's background health conditions and, therefore, it would be expected to misclassify patients defined as at low risk but with new-onset life-threatening conditions. According to the data presented here, this does not appear to majorly compromise its prognostic performance.

A prognostic assessment solely based on administrative data should never substitute a thorough consideration of patients' clinical conditions but rather represent only a first preliminary step. The SC could also be used as an objective and low-cost tool for risk adjustment in health services research, when comparing health outcomes across different facilities or evaluating changes in the performance of health care systems with time.

Study limitations should be acknowledged. Because of the substantial time lag between each episode of care (hospitalization, drug dispensation) and availability of the corresponding computerized data, the SC was reconstructed retrospectively several months after enrollment. Thus, so far, it has never been used as a real-time triage aid: To this purpose, data flow from administrative archives must be rapidly integrated and processed, a goal that should be easily reached with current computer technology and an affordable resource investment. The sample enrolled was very old and the hospital where the study was conducted has a dedicated geriatric ED with trained staff, two conditions that cannot be generalized to most hospitals. Admittedly,

external validity is probably further limited by exclusion of nighttime arrivals and preselection of participants by community emergency services as nontrauma cases. Other clinical events, such as change in functional status or incident delirium, are important in hospitalized older patients and might have been considered as study outcomes but, unfortunately, were unavailable. Finally, as data on recurrent ED access or hospitalization were limited to the Marche region, we might have missed events occurring elsewhere; however, out-of-region use of hospital services are negligible, especially at an old age.

In conclusion, we have provided evidence that the SC, using simple administrative data, offers a good prognostic assessment, at least as accurate and valid as the ISAR, of older patients who access an ED for medical reasons, in terms of need for hospital admission and mortality in the acute phase and of return ED visit, hospitalization, and mortality long term.

Funding

This study was supported in part by the grant "Modelli Innovativi per la presa in carico del paziente anziano fragile nella transizione dall'ospedale al territorio e dal territorio all'ospedale: case management e qualità della vita" from the Italian Center for Disease Control of the Italian Ministry of Health.

Supplementary Material

Supplementary Appendix Tables A1–A3 can be found at: http://biomedgerontology.oxfordjournals.

Conflict of Interest

The authors have no significant conflicts of interest and have no financial interests related to the material in the manuscript, and all have read and approved the submission of the manuscript.

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