Int J Clin Exp Med 2015;8(4):4778-4786
www.ijcem.com /ISSN:1940-5901/IJCEM0005825

Review Article

A systematic review of the identification of seniors at risk (ISAR) tool for the prediction of adverse outcome in elderly patients seen in the emergency department

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Received January 12, 2015; Accepted March 20, 2015; Epub April 15, 2015; Published April 30, 2015

Abstract: The purpose of this systematic review was to evaluate the predictive validity of the Identification of Seniors at Risk (ISAR) Tool in identifying elderly patients at risk of adverse outcomes after a visit to the emergency department (ED). Since older adults are frequently sent to the ED, screening for risk of adverse outcomes in elderly patients is increasingly important in the ED. Also it is a way to ensure that interventions based on a comprehensive geriatric assessment (CGA) are provided to patients identified at risk to reduce the risk of adverse outcomes. The ISAR is a six-item risk-screening tool for elderly patients seen in the ED. However the predictive validity of ISAR is controversial. Relevant studies from January 1999 through December 2014 were searched systematically in PubMed, Cochrane Library, Web of Knowledge, Scopus, CINAHL, Elsevier ScienceDirect databases. The language was restricted to English. This review was based on the recommendations of the Cochrane Handbook of Diagnostic Test Accuracy Reviews. Ten studies (8680 patients) were included in this review. With a cutoff score at least 2, the ISAR was proved to have poor validity related to revisiting the ED (AUC: 0.59-0.60) and hospital readmission (AUC: 0.59-0.60). The predictive validity of the ISAR related to mortality and composite outcomes was graded as poor to fair. It is not suitable to use the ISAR alone for identifying seniors at risk for adverse outcomes in the ED.

Keywords: Aged, emergency treatment, risk screening, systematic review

Introduction

In recent years, there has been a steady increase in the number of visits to the ED in many countries [1]. The percentage of people aged 65 years and older seen in the ED will nearly double in the next 25 years [2]. For elderly patients, a visit to the ED seems to be a sentinel health event [3]. Compared with younger adults seen in the ED, elder patients are at greater risk of adverse health outcomes, including revisits to the ED, hospitalization, institutionalization, functional decline, and death after return home [4]. Validated and rapid risk screening instruments are needed because of the increasing number of elderly patients being seen the ED [5]. For high-risk groups, such as the elderly comprehensive geriatric interventions have been shown to be more effective in reducing adverse outcomes than for the general population [6]. Thus, many risk screening tools for elderly patients after being seen in the ED were developed in the past twenty years, such as the Runciman questionnaire [7], the Rowland questionnaire [8], the ISAR [3], the triage risk screening tool (TRST) [9], the Variable Indicative of Placement risk (VIP) [10] and the silver code (SC) [11]. The ISAR and the TRST are the two most studied tools [12]. There has already been a systematic review on the predictive validity of the TRST [13]. However, to date no systematic review on the predictive validity of ISAR has been undertaken.

The ISAR is a self-report screening tool composed of six simple "yes/no" items, related to functional dependence, recent hospitalization, impaired memory and vision, polypharmacy [3]. The total scale range is from 0 to 6, as each item is scored 1 if the patient reports having

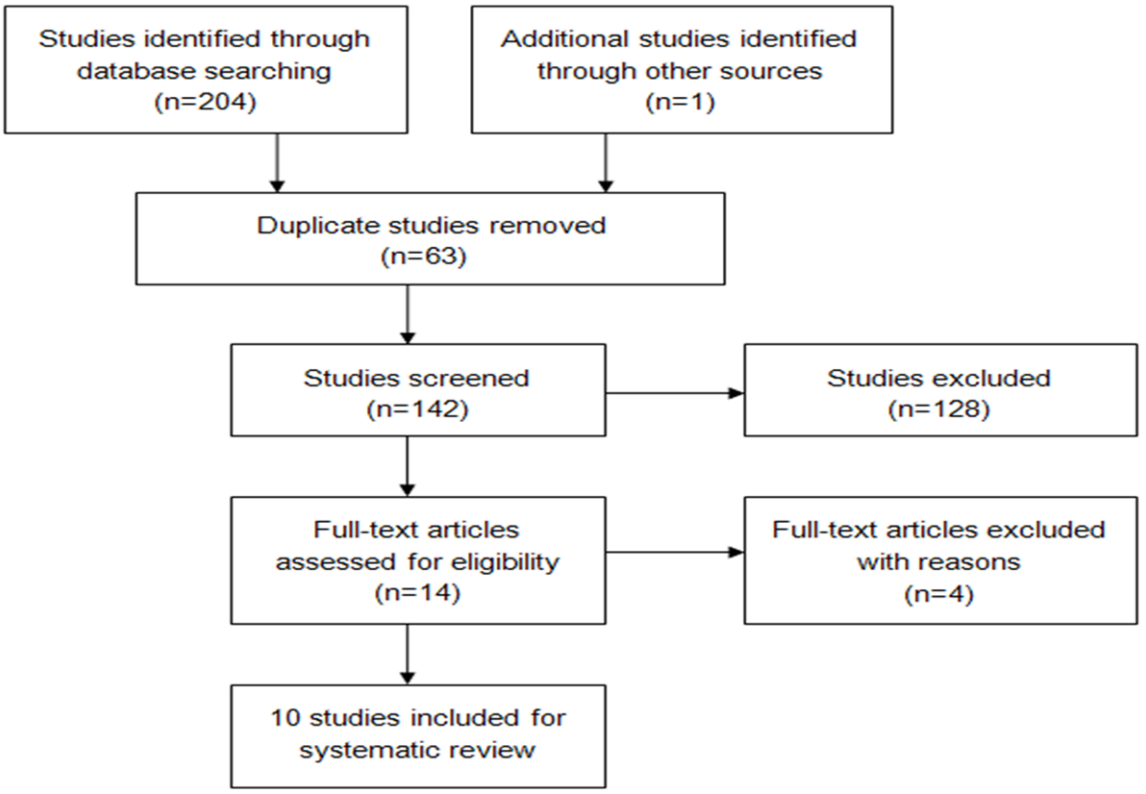

Figure 1. Consort diagram of the literature review process.

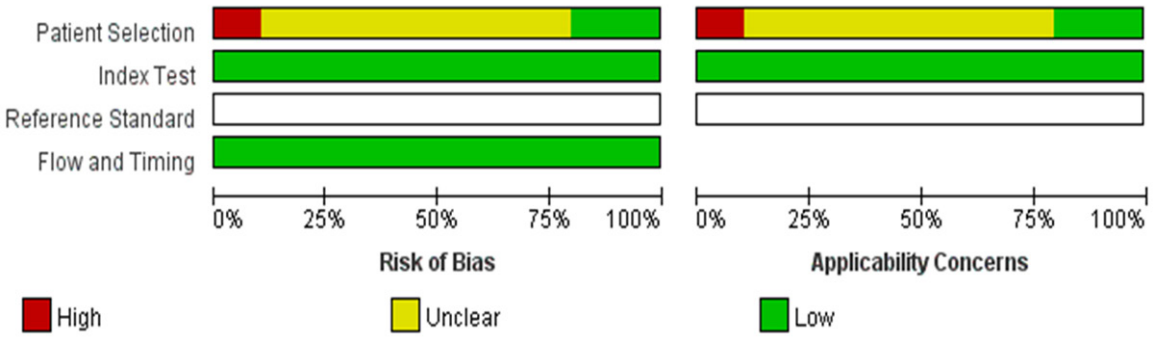

Figure 2. Summaries of quality appraisal.

the problem and 0 if not [3]. The ISAR was developed and validated in EDs in Canada in 1999, to identify elderly patients at risk of adverse health outcomes, including: functional decline, revisits to the ED, hospitalizations, institutionalization, and mortality within 6 months after being seen in the ED with a cutoff score of 2 [3]. The ISAR predictive validity can be expressed in sensitivity and specificity. As one of the most commonly used tools, the ISAR has been validated in several countries since 1999 where its predictive validity varied between 'fair' and 'poor' [14]. We conducted a comprehensive, systematic review of the ISAR to evaluate its predictive validity for identifying elderly patients at risk of adverse health outcomes after being seen in the ED because of the conflicting findings and conclusions in previous studies.

Methods

This systematic review was conducted based on the Cochrane Handbook of Diagnostic Test Accuracy Reviews [15].

Search strategy

PubMed, Cochrane Library, Web of Knowledge, Scopus, CINAHL, Elsevier ScienceDirect databases were searched by the combination of free words and MeSH terms. The research was limited to articles published between January 1999 and December 2014, and to articles written in English. The main search terms included "Identification of Seniors at Risk", "ISAR", "emergency treatment", "emergency room", "emergency department". Retrieved references were searched by hand to identify additional articles.

Inclusion criteria

To be included in review studies had to meet the following criteria: (a) prospective or retrospective cohort study in the ED; (b) evaluated the predictive ability of ISAR for elderly patients aged 65 years or older presenting to the ED; (c) recorded adverse outcomes including revisits to the ED, hospitalization, mortality and composite outcomes; (d) the follow-up time was at least 14 days.

Study selection

First, the studies identified were screened independently by two reviewers according to the titles and/or abstracts, then final full-text review was conducted to assess eligibility. Disagreements were resolved by discussion between reviewers.

Study quality appraisal

A modified Quality Assessment of Diagnostic Accuracy Studies tool (Quadas-2), which consists of two aspects (Risk of bias and Applicability) was used to appraise the methodological quality of the studies by two reviewers independently [13, 16]. Quality appraisal was carried out in the Review Manger 5.2 (Nordic Cochrane Center, Copenhagen, Denmark). Disagreements about assessments were resolved through discussion.

Data extraction

The data extracted included following items: author, year, country, study design, patient characteristics, patient selection, time to follow up. As well as the definition of polypharmacy, single outcome and composite outcome. The data were extracted by the two reviewers independently. Final results were compared in order to reach a consensus.

Results

Search outcomes

The initial search retrieved 204 relevant articles, including one article identified by hand searching. After the removal of duplicates, there were 142 articles available for further title and/or abstract review. Fourteen articles appeared to be in accordance with the inclusion criteria. The full text of these 14 articles was reviewed. Finally, 10 studies were eligible for systematic review while 4 were excluded for failing to meet the inclusion criteria. One study [17] was excluded because it was a review. Two articles were excluded because they included only hospitalized patients rather than all the elderly patients seen in the ED [18, 19]. Hospital utilization as the study outcome was the reason for another exclusion [20]. A Consort diagram of the literature review process is presented in **Figure 1**.

Ten studies [2, 3, 5, 12, 14, 21-25] with a total of 8680 participants were included in this review. Summaries of quality appraisal including Risk of bias and Applicability are presented in **Figure 2**.

Characteristics of studies selected are included in **Table 1**. Apart from Canada, there was evidence for the validity of the ISAR from Belgium, Italy, Netherlands, Switzerland, United Kingdom and Germany. Three of the ten studies were of elderly patients who aged 75 or older, one was of patients aged 70 or older, while six were of patients aged 65 or older. The follow-up time ranges from 14 days to 6 months. Outcomes included single outcomes and composite outcomes. Revisits to the ED (including early revisits, late revisits, frequent revisits), hospital readmission, functional decline, mortality, and institutionalization were also included. The following are the results for each single outcome and composite outcome.

Predictive validity for ED revisit

The four articles [2, 5, 21, 22] on the predictive validity of the ISAR for revisits to the ED are shown in **Table 2**. Only one study [2] reported predictive validity for revisits to the ED within

Table 1. Characteristics of studies selected for review

Author (Year), Country	Study design	Patient characteristics	Patient selection	Time to follow up	Definition of polypharmacy	Single outcome	Composite outcome
McCusker (1999), Canada [3]	prospective cohort	1673 pat; Age (yrs): 65-74 (49.1%), 75-84 (38.2%), 85+ (12.7%); Male: 43.4%	Aged ≥ 65; community-dwelling patients came to the EDs; excluded if could not be interviewed either because of medical condition or cognitive impairment and no other informant was available	6 months	≥ 3 drugs	NR	Death/Institution-alization/Hospital readmission/ Functional decline prevalence: 51%
McCusker (2000), Canada [25]	observational cohort	1122 pat; Age (yrs): 65-74 (52.2%), 75-84 (37.0%), 85+ (10.8%); Male: 43%	aged ≥ 65; released from the ED; stable medical status ,and either orientation to time and place or availability of an informant; excluded if could not be interviewed, refused linkage of study data, or were admitted to hospital at the initial visit	30 days 6 months	≥ 3 drugs	ED return 6 months: 43.9% Early return 30 days: 19.3% Frequent return* 6 months: 7.5%	NR
Moons (2007), Belgium [24]	Longitudinal	83 pat; Age (yrs, mean): 74; Male: 45.8%	Aged ≥ 65; discharged from the ED within 24 h; Dutch speaking, could be reached by telephone; patients with significant cognitive decline or unable to give informed consent were included if a primary caregiver was present and can provided proxy consent	14, 30, 90 days	≥ 3 drugs	NR	ED revisit/Hospital readmission 14 days: 10% 30 days: 15.8% 90 days: 32.5%
Salvi (2009), Italy [21]	prospective observational cohort	200 pat; Age (yrs): 80.3 (SD7.4); Male: 42.5%	Aged ≥ 65; presenting to ED; excluded if under 65, previously enrolled in this study, had cognitive impairment and no available proxy, presented for trauma.	30 days, 6 months	≥ 3 drugs	Early ED revisit 30 days: 26.5% Late ED revisit 6 months: 46.5% Frequent ED revisit 6 months: 12% Hospital readmission 30 days: 13.3% 6 months: 32.5% Functional decline 6 months: 28.4% Mortality 30 days: 6.5% 6 months: 19.5%	Death/Long-term care (LTC) placement/Functional decline 6 months: 44.4% Death/LTC placement/Functional decline/ED revisit/Hospital readmission 6 months: 76.8%
Buurman (2011), Netherlands [2]	prospective cohort	381 pat; Age (yrs, mean): 79.1 (SD 6.3); Male: 38.8%	Aged ≥ 65; discharged from the ED; excluded if unable to contact within 4 days after discharge, unable to speakor understand Dutch, did not provide informed consent	30, 120 days	≥ 3 drugs	ED revisit: 30 days: 6% 120 days: 15% Hospital readmission 30 days: 8% 120 days: 17%	ED revisit/Hospital readmission/ Mortality 30 days: 9% 120 days: 20%
Di Bari (2012), Italy [22]	prospective cohort	1632 pat; Age (yrs, mean): 84 (SEM 5.5); Male: 39%	Aged ≥ 75; accessing a geriatric ED; excluded if unable to provide reliable information and consent and lacking a caregiver	6 months	≥ 3 drugs	669 (44)† 527 (34)† 239 (16)† ED return visit 6 months: 44% Hospital readmission 6 months: 34% Mortality 6 months: 16%	NR

Graf (2012), Switzerland [12]	historical cohort	345 pat; Age (yrs, mean): 83.9 (SD 5.7); Male: 37%	aged ≥ 75; CTAS ≥ 3/4; released home after an ED visit	1, 3, 6, 12 months	≥ 3 drugs	NR	ED revisit/Hospital readmission 1 month: 25% 3 months: 38% 6 months: 49% 12 months: 60%
Salvi (2012), Italy [5]	prospective observational	2,057 pat; Age (yrs): 81.7 (SD7.7); Male: 40%	aged ≥ 65; accessing ED; excluded if unable to provide reliable information and consent in absence of a caregiver	30 days, 6 months	≥ 5 drugs	Early ED return 30 days: 17% ED return visit 6 months: 41% Hospital admission 6 months: 31% Death 6 months: 13%	NR
Edmans (2013), United Kingdom [14]	observational cohort	667 pat; Age (yrs): 80; Male: 42.1%	aged ≥ 70; discharged from acute medical units; excluded if lacked mental capacity to give informed consent and if there was no family consultee available	90 days	≥ 3 drugs	NR	Death/Institutionalization/Hospital readmission/Increased dependency in activities/Reduced mental well-being/Reduced quality of life 90 days: 76%
Singler (2014), Germany [23]	prospective observational cohort	520 pat; Age (yrs): 82.8 (SD5.0); Male: 39.8 %	aged ≥ 75; admitted to the ED	28, 180 days	≥ 6 drugs	Death 28 days: 8.8% 180 days:26.0% Hospital Readmission 28days: 18.1% 180 days: 34.0% ED revisit 28days: 16.0% 180 days: 32.7% Nursing home admission 28 days: 3.7% 180 days: 3.1%	Death/Hospital Readmission/ED revisit/Nursing home admission 28 days: 48.1% 180 days: 50%

Pat, patients; yrs, years; NR, not reported; CTAS, Canadian Emergency Department Triage and Acuity Scale. *: frequent ED return (≥ 3 ED return visits in 6 months).

Table 2. Predictive validity of ED revisit

Author (Year)	Time to follow up	Sensitivity (95% CI)	Specificity (95% CI)	PPV	NPV	AUC (95% CI)
Buurman (2011) [2]	120 days	0.56	0.54	0.19	0.90	0.59 (0.51-0.67)
Salvi (2009) [21]	6 months	0.61 (0.52-0.70)	0.56 (0.42-0.69)	NR	NR	NR
Di Bari (2012) [22]	6 months	NR	NR	NR	NR	0.59 (0.56-0.62)
Salvi (2012) [5]	6 months	0.74	0.39	0.39	0.68	0.60 (0.57-0.62)

NR, not reported.

Table 3. Predictive validity of hospital readmission

Author (Year)	Time to follow up	Sensitivity (95% CI)	Specificity (95% CI)	PPV	NPV	AUC (95% CI)
Edmans (2013) [14]	90 days	0.76 (0.69-0.82)	0.33 (0.29-0.38)	0.29	0.79	0.60 (0.55-0.65)
Buurman (2011) [2]	120 days	0.65	0.54	0.22	0.88	0.59 (0.52-0.67)
Salvi (2009) [21]	6 months	0.44 (0.35-0.54)	0.71 (0.58-0.82)	NR	NR	NR
Di Bari (2012) [22]	6 months	NR	NR	NR	NR	0.60 (0.57-0.63)
Salvi (2012) [5]	6 months	0.77	0.38	0.36	0.78	0.63 (0.60-0.66)

NR, not reported.

Table 4. Predictive validity of Mortality

Author (Year)	Time to follow up	Sensitivity (95% CI)	Specificity (95% CI)	PPV	NPV	AUC (95% CI)
Edmans (2013) [14]	90 days	0.85 (0.69-0.95)	0.32 (0.28-0.35)	0.60	0.97	0.62 (0.53-0.71)
Buurman (2011) [2]	120 days	0.64	0.51	0.40	0.98	0.58 (0.41-0.74)
Di Bari (2012) [22]	6 months	NR	NR	NR	NR	0.70 (0.66-0.73)
Graf (2012) [12]	6 months	0.91	0.37	0.18	0.96	0.74 (0.71-0.77)

NR, not reported.

120 days. Sensitivity was 0.56 and specificity was 0.54; positive predictive value (PPV) was 0.19 and negative predictive value (NPV) 0.90; areas under the receiver operating characteristic (ROC) curve (AUC) was 0.59 (95% CI 0.51-0.67). The ISAR only performed modestly (AUC ranging from 0.59-0.60) in predicting revisits to the ED within 6 months after an earlier visit to the ED, with sensitivity 0.61-0.74, and specificity 0.39-0.56.

Predictive validity for hospital readmission

Table 3 provides an overview of five studies [2, 5, 14, 21, 22] assessing the predictive validity ISAR related to hospital readmission. One study [14] showed that the ISAR was 'poor' at predicting hospital readmission within 90 days with sensitivity 0.76, specificity 0.33, PPV 0.29, NPV 0.79, AUC 0.60 (95% CI: 0.54-0.65) [14]. Another study [2] reported similar predictive validity for hospital readmission of the ISAR within 120 days (AUC: 0.59, 95% CI: 0.52-0.67) [2]. Within 6 months, three studies [5, 21, 22] reported that ISAR had moderate AUC (range: 0.60 to 0.63) in predicting the hospital readmission, sensitivity and specificity ranged from 0.44 to 0.77 and from 0.38 to 0.71, respectively.

Predictive validity for mortality

There are four studies [2, 12, 14, 22] assessing the predictive validity of the ISAR related to mortality. They are presented in **Table 4**. Two studies [12, 22] suggested that the predictive validity of the ISAR within 6months was 'fair' for mortality as the end point, with the AUC ranging from 0.70 to 0.74. The AUC at 90 days and 120 days were 'poor', 0.62 and 0.58 respectively.

Predictive validity for composite outcome

The summaries of sensitivity, specificity, PPV, NPV, AUC for the composite outcomes are presented in **Table 5**. Seven studies [2, 3, 12, 14, 21, 23, 24] reported various composite outcomes. The AUC ranged from 0.6 to 0.7, suggesting that the prognostic performance of the

Table 5. Predictive validity of Composite outcome

Author (Year)	Definition	Time to follow up	Sensitivity (95% CI)	Specificity (95% CI)	PPV	NPV	AUC (95% CI)
McCusker (1999) [3]	Death/Institutionalization/Hospital readmission/Functional decline	6 months	0.72	0.58	NR	NR	NR
Moons (2007) [24]	ED revisit/Hospital readmission	14 days	1	0.38	0.15	1	0.70
		30 days	0.79	0.37	0.22	0.89	0.60
		90 days	0.79	0.41	0.37	0.82	0.63
Salvi (2009) [21]	Death/Long-term care (LTC) placement/Functional decline	6 months	0.57 (0.47-0.66)	0.81 (0.69-0.90)	NR	NR	NR
	Death/LTC placement/Functional decline/ED revisit/Hospital readmission	6 Months	0.85 (0.77-0.90)	0.41 (0.28-0.54)	NR	NR	NR
Buurman (2011) [2]	ED revisit/Hospital readmission/Mortality	120 days	0.6	0.54	0.26	0.87	0.60 (0.53-0.67)
Graf (2012) [12]	ED revisit /Hospital readmission	1 month	0.918	0.22	0.28	0.89	0.61 (0.55-0.68)
		3 months	0.932	0.26	0.44	0.86	0.66 (0.60-0.71)
		6 months	0.918	0.29	0.56	0.78	0.66 (0.60-0.72)
		12 months	0.908	0.32	0.67	0.70	0.66 (0.61-0.72)
Edmans (2013) [14]	Death/Move to care home/Hospital readmission/Increase in dependency/Reduced mental wellbeing/Reduced quality of life	90 days	0.71 (0.66-0.75)	0.43 (0.34-0.52)	0.79	0.32	0.60 (0.54-0.65)
Singler (2014) [23]	Death/Hospital Readmission/ED revisit/Nursing home admission	28 days	0.89 (0.84-0.92)	0.25 (0.20-0.30)	NR	NR	NR
		180 days	0.90 (0.87-0.94)	0.27 (0.22-0.33)	NR	NR	NR

NR, not reported.

ISAR for composite outcomes was 'poor' to 'fair'.

Discussion

The usefulness of valid, rapid, and low-cost screening tools to identify of seniors at risk for adverse health outcomes in an ED setting cannot be overemphasized [5]. In this review, as one of the most widely used tools, the ISAR seems to be useful for screening high-risk aged patients seen in the ED, but it's discriminating value in predicting adverse health outcomes was 'poor' to 'fair' for elderly patients released from the ED (AUC: 0.58-0.74). It was shown to have 'fair' predictive validity in only three studies, two of which used mortality at 6 months as the outcome. [5, 22], while one used a composite outcome (ED revisit/Hospital readmission) [24]. The three studies were all conducted in European countries, i.e. Belgium and Italy. Health care systems, community services, organizations and the availability of home-based care services, and the pattern of ED use in various countries may account differences in the predictive validity of the ISAR [21, 23]. These differences indicate that the original ISAR should be modified according to the health related environment of country in which it is used.

Items such as polypharmacy will also affect the prognostic performance of the ISAR. As shown in **Table 1**, two studies choose different cutoff in the number medications included in the polypharmacy item, 5 drugs and 6 drugs respectively [5, 23]. A higher threshold for the polypharmacy item has been suggested to improve the predictive performance of the ISAR [21, 26, 27]. Further studies are warranted to identify the best cutoff for the polypharmacy item.

In one study [22] the participants were older adults aged 75 years or older, while most studies chose patients aged 65 years or older. Older age may explain the fair rather than poor prognostic performance [22], it was also reported that the specificity of the ISAR could decrease with age [12].

In addition, all studies included used a cutoff score ≥ 2 points, which is consistent with the original study. But it was suggested that using ≥ 3 points as a cutoff seems to be better in terms of specificity [23]. More studies are needed to determine which cutoff score (ranging from 0 to 6) is the most appropriate.

As a screening tool for seniors seen in the ED, the ISAR has some clinical value although the prognostic performance is not very satisfacto-

ry. It has been suggested that the ISAR should be applied to clinical decision-making, and the stratification and selection of patients to be included in clinical trials [14].

This study was the first systematic review of predictive validity of the ISAR. Our search method was rigorous and the quality evaluation method by modified Quadas-2 was crucial.

This review has some limitations. First, the included studies were limited to published articles in English. Second, because of the heterogeneity of the studies, it was impossible to carry out meta analysis. Third, because some information was not available, the overview of the ISAR is not as comprehensive as one would like.

In conclusion, the ISAR is limited in its predictive ability at the usual cutoff ≥ 2 points to detect elderly patients at risk of adverse health outcomes following a visit to the ED. Further work is required to improve the predictive ability of ISAR as well as provide interventions based on CGA and locally available resources.

Disclosure of conflict of interest

None.

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