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RESEARCH PAPER

Development and validation of the delirium risk assessment score (DRAS)

Ralph Vreeswijk[1] · Imke Kalisvaart[3] · Andrea B. Maier[2,4] · Kees J. Kalisvaart[1]

Key summary points

Aim To develop an easy-to-use delirium risk assessment score (DRAS) to establish if a patient admitted to a hospital is at risk of getting delirium.

Findings Our delirium risk assessment score (DRAS) based on the admission interview showed that risk of delirium based on predisposing risk factors can be assessed easily without elaborate cognitive testing and/or laboratory results and therefore less stressful for the patient. The DRASs as good as or somewhat better than other risk assessment scores are not developed for one specific population.

Message Because there is still a lack of knowledge, competence and awareness regarding delirium, understanding delirium risk factors helps clinicians, patients and caregivers in targeting non-pharmacological and pharmacological interventions aimed at lessening its burden.

Abstract

Purpose Development and validation of a delirium risk assessment score. Predisposing risk factors for delirium were used, which are easily assessed at hospital admission without additional clinical or laboratory testing.

Methods A systematic literature search identified ten risk factors: acute admission, alcohol use > 4 units/day, cognitive impairment, ADL impairment, age > 75 years, earlier delirium, hearing/vision problems, number of medication ≥ 5, number of morbidities > 2 and male. The DRAS was developed in a mixed patient population ($N = 842$) by the use of univariate and multivariate analyses and -2 log-likelihood calculation to weigh the risk factors. Based on the sensitivity and specificity, a cutoff score was calculated. The validation was performed in 3 cohorts ($N = 408$, $N = 186$, $N = 365$). In cohort 3, the DRAS was compared (AUC, sensitivity and specificity) to 3 instruments (Inouye, Kalisvaart, VMS rules).

Results The delirium incidence was 31.8%, 20.3%, 15.6% and 15.1%. All risk factors were independently predictive for delirium, except male. The multivariate analyses excluded morbidities. The final DRAS consists of 8 items; acute admission, cognitive impairment, alcohol use (3 points), ADLimpairment/mobilityproblems (2 points), higher age, earlier delirium, hearing/vision problems, and medication (1 point). The total score is 15 points and at a cut-of score of 5 or higher the patient is at risk of developing a delirium. The cutoff was at 5 or more points, AUC: 0.76 (95% CI 0.72–0.79), sensitivity 0.77, specificity 0.60. Validation cohorts AUC was 0.75 (95% CI 0.96–0.81), 0.76 (95% CI 0.70–0.83) and 0.78 (95% CI 0.70–0.87), sensitivity 0.71, 0.67 and 0.89 and specificity 0.70, 0.72 and 0.60. The comparison revealed the highest AUC for the DRAS.

Conclusion Based on an admission interview, the delirium risk can be easily evaluated using the DRAS shortlist score of predisposing risk factors for delirium in older inpatients.

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Introduction

Delirium is a serious complication in older inpatients [1–3]. It is multifactorial determined and based on a combination of predisposing and precipitating risk factors. Incidence rates for delirium vary among various hospital patient populations ranging from 5 to 87% [3]. Patients with delirium often have high morbidity and mortality, prolonged hospital length of stay and high rates of institutionalization and dementia following discharge [2–7].

The current guidelines and trials suggest that about one-third of all delirium episodes could have been prevented by assessing systematic programs, and that delirium prevention would be a cost-effective strategy [8, 9]. Recent studies also showed that there is a lack of knowledge, competence, awareness regarding delirium, prevention of delirium and the use of screening tools for detection and severity of delirium among clinicians [10–12]. There is also a relation between frail older people and delirium due to the fact that frail older people have also more predisposing risk factors for delirium than those who are not frail [13, 14]. Therefore, it seems prudent to screen hospitalized patients for their risk of delirium to create awareness that a patient is at risk and because clinicians can develop plans to mitigate the risk. Understanding delirium risk factors may even help clinicians, patients and caregivers in targeting non-pharmacological and pharmacological interventions aimed at lessening its burden.

Identification of modifiable predisposing and precipitating risk factors for delirium is a prerequisite for an individual approach for the prevention of delirium. The predisposing delirium risk factors are already identifiable on admission, and the amount of predisposing risk factors present denotes the older patient's vulnerability for delirium during admission [6]. Several screening instruments have been suggested to detect patients at risk of delirium. Lindroth (2018) found 23 prediction screening instruments [15]. The instruments in this review showed that they were often based on complex methods such as scale administration (MMSE, Barthel, KATZ, GDS) and interpretation of laboratory measurements which need time and knowledge to perform, and they were developed for specific patient populations and are not validated.[9, 16–24]

The aim of this study was to evaluate whether patient characteristics of older patients admitted to a hospital, which can be assessed quickly and easily on admission based on an admission interview and without additional clinical or laboratory testing, may serve to stratify older inpatients with respect of their delirium risk.

Methods

Participants and setting

In this study four different patient cohorts were used, a development cohort and three validation cohorts.

The development cohort, consisting of a population of 842 older patients (mixed surgical/non-surgical) who were admitted to a teaching hospital in the Spaarne Gasthuis in Haarlem from 2009 till 2011, was used to develop the prediction screening instrument delirium risk assessment score (DRAS). The DRAS was validated using three cohorts. Validation cohort 1 is a cohort of 408 orthopedic patients admitted to the same hospital in 2010 till 2012. Validation cohort 2 is a cohort of 186 surgical patients admitted in 2016 to the Spaarne Gasthuis hospital in Haarlem. Validation cohort 3 is a cohort of 365 of 603 orthopedic patients from the Haloperidol study population that took place in 2000 to 2002 in the Medisch Centrum Alkmaar hospital in Alkmaar, the Netherlands [25]. The validation was done retrospective because data were already available. The haloperidol study included in total 603 patients, but due to missing data at admission 238 out of 603 patients had to be excluded from analysis of the third validation cohort.

Inclusion and exclusion criteria were the same in all populations. Included were all people with the age 65 or over, no delirium on admission (CAM and confirmation by a geriatrician) and hospital stay ≥ 72 h. Consent was obtained by patient or relative (if the patient was not able to give consent).

Risk factors and assessment on admission

The potential predisposing risk factors for delirium were selected after a systematic review of the literature published from 1990 to 2008 and using reviews published from 2008 to 2011 [25–32]. Risk factors which are independent associated with delirium found in the literature were: older age, male gender, sensory impairment (visual and hearing impairment), cognitive comorbidity (dementia, cognitive impairment, depression), acute admission, functional impairments and disability (immobility, functional dependence, fracture on admission), malnutrition (alcoholism, dehydration), polypharmacy and medical comorbidity (high burden of illness). The predisposing risk factors that were selected were based on their characteristics to be easy to assess without additional clinical or laboratory test results. This resulted in the following potential predisposing risk factors for delirium: acute vs planned admission, alcohol use ≥ four units per day vs < four units, cognitive impairment yes vs no, hearing/

vision problems yes vs no, help needed for activities of daily living (ADL) yes vs no, age ≥ 75 vs < 75 years, previous delirium yes vs no, number of medication ≥ 5 vs < 5, number of morbidities > two vs ≤ two and male yes vs no. Cognition was scored as diagnosis of dementia, or if patient or their relative mentioned any cognition problems. The patient ability to perform activities of daily living (ADL) was scored if patients and/or relatives mentioned any help for ADL at home and/or needed devices as support for their mobility. Patients and/or their relatives were asked whether they have experienced delirium, confusion or disorientation in a previous admission. Hearing and vision problems were scored if patient was not able to solve hearing and/or vision problems by using glasses or a hearing aid.

In the validation cohort 3 data were used out of an existing database, and the risk factors for the DRAS were established as follows: For cognition, a Mini-Mental State Examination (MMSE) score of ≤ 24 points was used [33], and for vision problems, the Snellen vision test (> 20/70) was used [34]. Other risk factors were measured in the same way as in the development cohort.

Test characteristics of the DRAS were compared with the Inouye risk score and the Kalisvaart risk screening instrument and the Dutch Safety Monitoring (Veiligheids Management System (VMS)) screening instrument [9, 21, 35]. The variables used in these tools are already available in the data. The Inouye model is a well-known risk model cited in more than 800 articles and often used in research. The Dutch hospitals use the VMS in daily practice to screen for patients at risk.

For the Inouye risk screening instrument, the following 4 risk factors were scored: cognitive impairment (MMSE)[30] score of ≤ 24 points on a scale of 0 to 30 points, visual impairment, defined as binocular near vision, Snellen vision test worse than 20/70 after correction vision [36], index of dehydration (ratio of blood urea nitrogen to creatinine of ≥ 18) and severity of illness, measured by the Apache II (Acute Physiology Age and Chronicle Health Examination), score of ≥ 16 on a scale of 0 to 70 [34] and for the Kalisvaart risk screening instrument the factors: age, cognition (MMSE ≤ 24 points) and acute admission. The VMS screening instrument for delirium uses 3 questions: 'Do you experience cognitive problems?', 'Have you needed ADL support within 24 h before admission?', 'Did you had a delirium during another admission?'. The VMS was not developed and validated in a scientific study but already used in the Dutch hospitals. That is why it is used to compare the DRAS with the VMS in this study.

Delirium Assessment

In the development cohort and the validation cohorts a brief delirium assessment (< 15 min) was performed daily from day one till three days after admission or operation by trained interviewers which could be a research nurse or a doctor not involved in the patient's treatment to screen for delirium symptoms by the use of confusion assessment method (CAM) [37] assessed delirium. If the patient scored positive on the CAM, a geriatrician confirmed the diagnosis based on DSM-IV and DSM-V. The daily assessment was augmented with medical and nursing record review for evidence of intervening delirium features (e.g., acute onset, inattention, disorganized thinking, altered level of consciousness, disorientation, memory impairment, perceptual disturbances, psychomotor agitation or retardation and altered sleep–wake cycle) and medical treatment for delirium.

Statistics

Statistical calculations were performed using SPSS for Windows, version 18.0 (SPSS, Chicago Inc. Chicago, IL). Each potential risk factor for delirium was tested with the primary outcome measurements using Chi-square tests for nominal variables, the Mann–Whitney U test for ordinal variables and the unpaired 2-tailed t test for continuous variables. A logistic univariate regression analyses were performed to establish if the predisposing risk factor was related to the development of delirium. All used risk factors with a value of $P < 0.2$ were included in the multivariate stepwise logistic regression analysis. To facilitate the use of the DRAS, we developed weights for all risk factors based on the odds ratios (OR) of the estimated risk factor.

The performance of the risk model (DRAS) was measured using receiver operating characteristic (ROC) analysis. For the best performance of the DRAS, a cutoff point was calculated using the best score on sensitivity and specificity. Furthermore, for the comparison part of this study the sensitivity and specificity were calculated of the other screening instruments used.

The studies were done in accordance with the Declaration of Helsinki and the guidelines on good clinical practice. Approval was obtained from the AdviesCommissie Locale Uitvoerbaarheid (ACLU), the local committee of the METC of our hospital. All patients and relatives were informed verbally. Patients and/or relatives gave their verbal consent for obtaining the data.

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Results

The delirium incidence was 268/842 (31.8%) in the development cohort, 83/408 (20.3%) in validation cohort 1, 28/186 (15.1%) in validation cohort 2 and 57/365 (15.6%) in validation cohort 3.

Demographic characteristics of the participants in the cohorts are described in Table 1.

Nine out of ten risk factors for delirium described in the literature were related to the development of delirium in the development cohort. Male gender was not significantly associated with delirium ($P = 0.051$). In the multivariate stepwise logistic regression analysis, comorbidity was the only risk factor which lost significance predicting delirium (Table 2). Of the ten used variables eight remain in the final model. The OR of the delirium risk factors was calculated to attribute weight to them. After weighing the risk factors, the final DRAS consisted of three points for acute admission, alcohol use and cognition impairment, two points to ADL impairment and one point to the other risk factors. The final DRAS has a ROC curve of AUC 0.76 (95% CI 0.72–0.79). The cutoff point was calculated using the best score on sensitivity and specificity and showed the best prediction of risk of delirium at a score of ≥ 5. In the development cohort 211 patients had five DRAS points or more accounting for 79% of the delirium incidence. Furthermore, the higher the

Table 1 Patient characteristics of the development and three validation cohorts stratified by delirium

	Development Cohort, N = 842		Validation cohort 1, N = 408		Validation cohort 2, N = 186		Validation cohort 3, N = 365	
	No delirium	Delirium	No delirium	Delirium	No delirium	Delirium	No delirium	Delirium
	N = 574	N = 268	N = 325	N = 83	N = 158	N = 28	N = 308	N = 57
Age								
Mean (SD)	79.3 (6.19)	81.8 (6.45)	78.5 (5.82)	82.7 (5.87)	79.7 (7.3)	80.6 (6.45)	78.3 (5.72)	82.1 (6.11)
75 years or older	428 (64.8)	233 (35.2)	236 (75.9)	75 (24.1)	102 (64.6)	23 (18.4)	218 (81.3)	50 (18.7)
Gender (male)	175 (30.5)	100 (37.3)	59 (18.2)	25 (30.1)	62 (83.8)	12 (16.2)	54 (17.5)	17 (29.8)
Acute admission	231 (54.1)	196 (45.9)	79 (59.4)	54 (40.6)	91 (78.4)	25 (21.6)	68 (68.7)	31 (31.3)
Alcohol, 4 or more units/ daily	24 (54.5)	20 (45.5)	16 (76.2)	5 (23.8)	5 (83.3)	1 (16.7)	16 (80.0)	4 (20.0)
Cognitive impairment	141 (50.0)	141 (50.0)	90 (66.7)	45 (33.3)	17 (58.6)	12 (41.4)	84 (68.3)	39 (31.7)
ADL problems	172 (53.8)	148 (46.2)	86 (73.5)	31 (26.5)	42 (72.4)	16 (27.6)	80 (78.4)	22 (21.6)
History of delirium	34 (56.7)	26 (43.3)	11 (68.8)	5 (31.2)	10 (66.7)	5 (33.3)	10 (71.4)	4 (28.6)
Vision/hearing problems	147 (56.8)	112 (43.2)	52 (67.5)	25 (32.5)	63 (80.8)	15 (19.2)	43 (75.4)	14 (24.6)
Medication 5 or more	229 (60.4)	150 (39.6)	102 (74.5)	35 (25.5)	71 (77.2)	21 (22.8)	90 (82.6)	19 (17.4)
Comorbidity, 2 or more illnesses	132 (55.5)	106 (44.5)	48 (60.8)	31 (39.2)	46 (75.4)	15 (24.6)	47 (65.3)	25 (34.7)

Results prescribed as N, (%) unless otherwise stated

Table 2 Development of the delirium risk assessment score (DRAS) to predict delirium in the development cohort (N = 842), univariate and multivariate analyses

Risk factors	Univariate			Multivariate			Final DRAS
	OR	95% CI	P	OR	95% CI	P	Points
Acute admission	4.04	2.94–5.55	< 0.001	2.99	2.12–4.22	< 0.001	3
Alcohol, 4 or more units/day	1.85	1.00–3.41	0.046	2.7	1.34–5.45	0.01	3
Cognitive impairment	3.41	2.51–4.63	< 0.001	2.4	1.72–3.36	< 0.001	3
ADL/mobility problems	2.88	2.14–3.89	< 0.001	1.91	1.36–2.68	< 0.001	2
Age, 75 years or older	2.27	1.52–3.39	< 0.001	1.46	0.93–2.28	0.14	1
Vision/hearing problems	2.09	1.54–2.83	< 0.001	1.34	0.95–1.90	0.10	1
Medication, 5 or more prescriptions	1.92	1.43–2.57	< 0.001	1.35	0.97–1.88	0.10	1
History of delirium	1.71	1.01–2.92	0.045	1.54	0.84–2.83	0.16	1
Comorbidity, 2 or more illnesses	2.19	1.60–1.49	< 0.001	Excluded		0.83	Excluded
Gender (male)	1.36	1.00–1.84	0.051	Excluded			Excluded

score the more patients developed delirium, at a score of 11 it was 82.4% and with a score of 12 to 14 it was 100%. The AUC of the validation cohorts ranges from 0.75 to 0.87, the sensitivity 0.67 to 0.89 and specificity from 0.60 to 0.72 (Table 3). 0.69

The comparison of the DRAS with other screening instruments for delirium (Kalisvaart, Dutch VMS and Inouye) revealed a somewhat higher AUC for the DRAS but overlapping confidence intervals: DRAS 0.75 (95% CI 0.69–0.82), Kalisvaart AUC 0.74 (95% CI 0.67–0.81), VMS AUC 0.69 (95% CI 0.62–0.77), Inouye AUC 0.66 (95% CI 0.59–0.74) (Fig. 1). The sensitivity for the DRAS was 0.67, Kalisvaart 0.78, VMS 0.75 and Inouye 0.97. The specificity for the DRAS was 0.72, Kalisvaart 0.66, VMS 0.58 and Inouye 0.14 (Table 3).

Discussion

The delirium risk assessment score (DRAS), based solely on information that is most times readily available, or easy to obtain and easy to interpret by nurses and doctors, has been shown to be satisfactorily accurate in the assessment of risk of delirium. Despite evidence of a high risk of developing delirium in all kinds of patient populations, reliable studies on risk factors and prediction of delirium by nurses and doctors are rare. In a review article of Lindroth et al. (2017), 23 delirium prediction models for different patient populations were identified of which 14 were externally validated. Of these 14 models the overall predictive ability was moderate to high with an AUC ROC range from 0.52 to 0.94 [15]. Besides these 14 studies two other studies can be found which are externally validated [38, 39]. Most of the found models used scales (MMSE, Clock drawing, Geriatric Depression Scale (GDS), APACHE II) and/or laboratory tests, which are laborious and time-intensive and require

training to be used in daily practice [15]. Furthermore, the results of cognition testing, e.g., MMSE or other patient-reported tests done on admission, are known to have low reliability when the patient is in stress of the admission, or is severely ill, unable to respond or is being tested at busy emergency departments [40]. Another point made by Woodford was that small cognitive screening tests for unselected populations may result in more false positives than true-positive cases. And the best method of classifying cognitive impairment is a comprehensive clinical evaluation [41].

Methodological shortcomings of the prediction model studies have been reported. The assessment of the outcome variable delirium was largely non-systematic, only once daily and not in weekends or every 48 h. In the studies that assessed delirium more than once per day, the assessment was performed by routine clinical staff, decreasing consistency [15]. This is a major limitation for an acute condition that fluctuates, may occur suddenly and is dependent on precise, objective assessment. Most studies used the confusion assessment method (CAM), but only a few confirmed the diagnoses by a geriatrician or psychiatrist.

To improve delirium prediction models, future models should consider using standard risk factors (predisposing and/or precipitating) used in daily care and should preferably be applicable for more populations. In the Netherlands, patients receive an admission interview administered by doctors and nurses when they are admitted to a hospital. In this admission interview most predisposing risk factors for delirium are established.

The DRAS is a simple delirium risk screenings instrument. It showed satisfactory validity to predict delirium in the development cohort and three validation cohorts. Its AUC of 0.75 in the development cohort and 0.78 in the validation cohort lays within the range of AUCs (0.53–0.81) of the other delirium prediction screenings instruments found in the literature [15]. But the strength of the DRAS is its

Table 3 Validity of the delirium risk assessment score (DRAS) in the development cohort, three validation cohorts and the comparison with two other

	Asymptomatic						
	N	AUC	95% CI		P	Sensitivity	Specificity
Validity of the DRAS in the development cohort							
Development cohort	842	0.75	0.72	0.79	<0.001	0.79	0.58
Validity of the DRAS in three validation cohorts							
Validation—cohort 1	408	0.75	0.69	0.81	<0.001	0.71	0.72
Validation—cohort 2	186	0.78	0.70	0.87	<0.001	0.60	0.89
Validation—cohort 3	365	0.75	0.69	0.82	<0.001	0.67	0.74
Validity of three other delirium risk screening tools in cohort 3							
Kalisvaart screening tool	365	0.74	0.67	0.81	<0.001	0.78	0.66
VMS screening tool	365	0.69	0.62	0.77	<0.001	0.75	0.58
Inouye screening tool	365	0.66	0.59	0.74	<0.001	0.97	0.14

Fig. 1 ROC curve in the comparison study of the DRAS with Kalisvaart screening instrument, Dutch VMS screening instrument and Inouye screening instrument ($N = 365$)
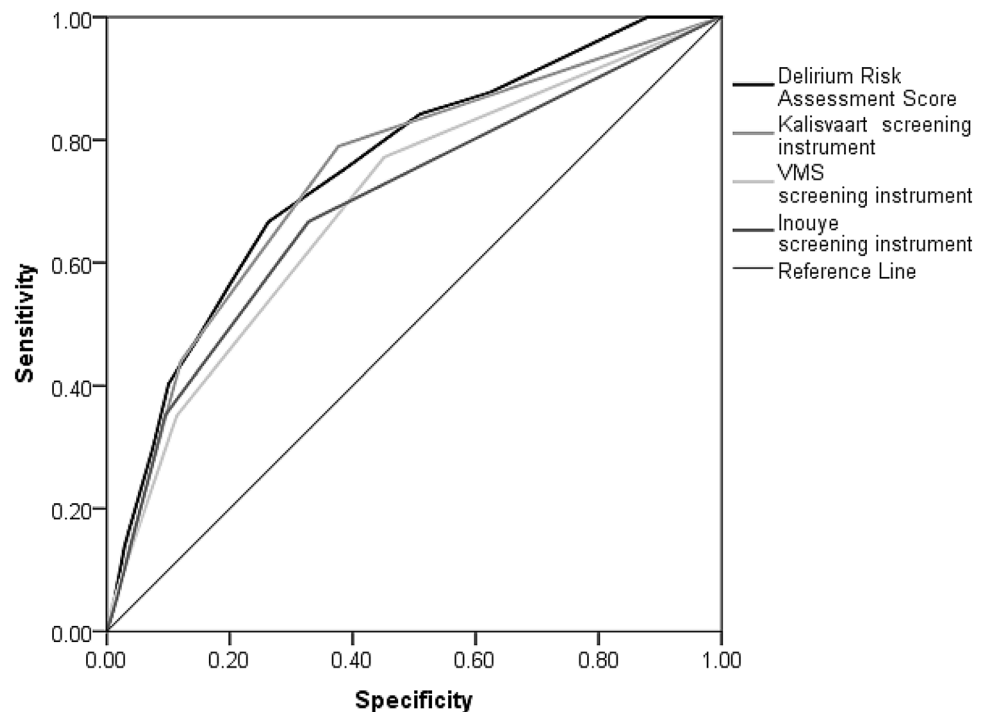
simplicity and feasibility in clinical practice: Each nurse and doctor can easily and quickly assess and interpret all of the DRAS risk items based solely on brief admission interview or just asking six simple questions to the patient or his/her relative.

The DRAS performs as accurately or somewhat better compared to the other screening instruments like the Kalisvaart screening tool [10], the Inouye screening tool [9] and the VMS screening tool [16]. The DRAS does not require elaborate testing (of which the outcome may not be reliable) [40, 41], laboratory results and/or training of nurses and doctors. Due to this, there is no delay in starting preventive interventions for delirium.

The strength in this study lays also in the fact that the DRAS was developed in a heterogeneous patient population, making it possible to use the DRAS in different patient populations. The large number of patients included underlines that our results are robust. Furthermore, the assessment of delirium in all our studies was done by a trained person on a daily basis using the confusion assessment method and the diagnosis was confirmed by a geriatrician.

The study limitations to be addressed are that the development and validation was not externally validated. There was a validation done in cohort 3 which came from another hospital, but of this cohort data were already available from another study. Also, preventive interventions for delirium done by the geriatric liaison service in our hospital may have possibly influenced the incidence rate of delirium. This study included all eligible patients from several wards, a heterogeneous patient population, in a general teaching

hospital, so the fact that the validation was limited to an orthopedic and surgical population may raise questions, but nevertheless, the results on DRAS risk assessment in the third validation cohort were the same or better compared to the other screening instruments.

Conclusion

Based on the admission interview, the delirium risk can be very easily evaluated by using the DRAS shortlist score of predisposing risk factors for delirium in older inpatients.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interests.

Ethical approval The studies were done in accordance with the Declaration of Helsinki and the guidelines on good clinical practice.

Approval was obtained from the Advies Commissie Locale Uitvoer-baarheid (ACLU), the local committee of the METC of our hospital.

References

1. Dyer CB, Ashton CM, Teasdale TA (1995) Postoperative delirium. Arch Intern Med 155:461–465
2. Galanakis P, Bickel H, Gradinger R, Von Gumppenberg S, Förstl H (2001) Acute confusional state in the elderly following hip surgery: incidence, risk factors and complications. Int J Geriatr Psychiatry 16(4):349–355
3. Lindesay J, Rockwood K, Rolfson D (2002) The epidemiology of delirium. In: Lindesay J (eds) Delirium in old age, Oxford University Press, Oxford, pp 27–50
4. McCusker J, Cole M, Abrahamowicz M, Primeau F, Belzile E (2002) Delirium predicts 12-month mortality. Arch Intern Med 162:457–463
5. Witlox J, Eurelings LS, de Jonghe JF, Kalisvaart KJ, Eikelenboom P, van Gool WA (2010) Delirium in elderly patients and the risk of post discharge mortality, institutionalization, and dementia: a meta-analysis. JAMA 304(4):443–451
6. Inouye SK, Charpentier PA (1996) Precipitating factors for delirium in hospitalized elderly persons. Predictive model and interrelationship with baseline vulnerability. JAMA 275(11):852–857
7. Inouye SK (1999) Predisposing and precipitating factors for delirium in hospitalized older patients. Dement Geriatr Cogn Disord 10(5):393–400
8. Cole MG, McCusker J, Bellavance F, Primeau FJ, Bailey RF, Bonnycastle MJ et al (2002) Systematic detection and multidisciplinary care of delirium in older medical inpatients: a randomized clinical trial. CMAJ 167:753–759
9. Inouye SK, Viscoli CM, Horwitz RI, Hurst LD, Tinetti ME (1993) A predictive model for delirium in hospitalized elderly medical patients based on admission characteristics. Ann Intern Med 119:474–481
10. Morandi A, Davis D, Taylor JK, Bellelli G, Olofsson B, Kreisel S, Teodorczuk A, Kamholz B, Hasemann W, Young J, Agar M, de Rooij SE, Meagher D, Trabucchi M, MacLullich AM (2013) Consensus and variations in opinions on delirium care: a survey of European delirium specialists. Int Psychogeriatr 25(12):2067–2075
11. Yaghmour SM, Gholizadeh L (2016) Review of Nurses' knowledge of delirium, dementia and depression (3Ds): systematic literature review. J Nurs 6:193–203
12. Kristiansen S, Konradsen H, Beck M (2019) Nurses' experiences of caring for older patients afflicted by delirium in a neurological department. J Clin Nurs 28(5–6):920–930
13. Verloo H, Goulet C, Morin D, Von Gunten A (2016) Association between frailty and delirium in older adult patients discharged from hospital. Clin Interv Aging 11:55–63
14. Quinlan N, Marcantonio ER, Inouye SK, Gill TM, Kamholz B, Rudolph JL (2011) Vulnerability: the crossroads of frailty and delirium. J Am Geriatr Soc 59(Suppl 2):S262–S268

15. Lindroth H, Bratzke L, Purvus S, Brown R, Coburn M, Mrkobrada M et al (2018) Systematic review of prediction models for delirium in the older adult inpatient. BMJ Open 8(4):e019223
16. Kalisvaart KJ, Vreeswijk R, de Jonghe JF, van der Ploeg T, van Gool WA, Eikelenboom P (2006) Risk factors and prediction of postoperative delirium in elderly hip-surgery patients: implementation and validation of a medical risk factor model. J Am Geriatr Soc 54(5):817–822
17. Marcantonio ER, Goldman L, Mangione CM, Ludwig LE, Muraca B, Haslauer CM et al (1994) A clinical prediction rule for delirium after elective noncardiac surgery. JAMA 271(2):134–139
18. Rudolph JL, Jones RN, Levkoff SE, Rockett C, Inouye SK, Sellke FW et al (2009) Derivation and validation of a preoperative prediction rule for delirium after cardiac surgery. Circulation 119:229–236
19. Vochteloo AJ, Moerman S, van der Burg BL, de Boo M, de Vries MR, Niesten DD et al (2011) Delirium risk screening and haloperidol prophylaxis program in hip fracture patients is a helpful tool in identifying high-risk patients, but does not reduce the incidence of delirium. BMC Geriatr 11(11):39
20. Koster S, Oosterveld FG, Hensens AG, Wijma A, van der Palen J (2008) Delirium after cardiac surgery and predictive validity of a risk checklist. Ann Thorac Surg 86(6):1883–1887
21. Praktijkgids Kwetsbare ouderen (online). Available at www.vmszorg.nl
22. Fortes-Filho SQ, Apolinario D, Melo JA, Suzuki I, Sitta Mdo C, Garcez Leme LE (2016) Predicting delirium after hip fracture with a 2-min cognitive screen: prospective cohort study. Age Ageing 45(5):713–717
23. Freter S, Dunbar M, Koller K, MacKnight C, Rockwood K (2015) Risk of pre-and post-operative delirium and the delirium elderly at risk (DEAR) tool in hip fracture patients. Can Geriatr J. 18(4):212–216
24. Douglas VC, Hessler CS, Dhaliwal G, Betjemann JP, Fukuda KA, Alameddine LR et al (2013) The AWOL tool: derivation and validation of a delirium prediction rule. J Hosp Med. 8(9):493–499
25. Scholz AF, Oldroyd C, McCarthy K, Quinn TJ, Hewitt J (2016) Systematic review and meta-analysis of risk factors for postoperative delirium among older patients undergoing gastrointestinal surgery. Br J Surg 103(2)
26. Raats JW, Steunenberg SL, de Lange DC, van der Laan L (2016) Risk factors of post-operative delirium after elective vascular surgery in the elderly: a systematic review. Int J Surg 35:1–6
27. Van Meenen LC, van Meenen DM, de Rooij SE, ter Riet G (2014) Risk prediction models for postoperative delirium: a systematic review and meta-analysis. J Am Geriatr Soc 62(12):2383–2390
28. Ahmed S, Leurent B, Sampson FL (2014) Risk factors for incident delirium among older people in acute hospital medical units: a systematic review and meta-analysis. Age Aging 43(3):326–333
29. Vasilevskis EE, Han JH, Hughes CG, Ely EW (2012) Epidemiology and risk factors for delirium across hospital settings. Best Pract Res Clin Anaesthesiol 26(3):277–287
30. Oh ES, Li M, Fafowora TM, Inouye SK, Chen CH, Rosman LM, Lyketsos CG, Sieber FE, Puhan MA (2015) Preoperative risk factors for postoperative delirium following hip fracture repair: a systematic review. Int J Geriatr Psychiatry 30(9):900–910
31. Lindesay J, Rockwood K, Macdonald A (2002) The causes of delirium, in Delirium in old age. Oxford University Press, Oxford
32. Laurila JV, Laakkonen ML, Tilvis RS, Pitkala KH (2008) Predisposing and precipitating factors for delirium in a frail geriatric population. J Psychosom Res 65(3):249–254
33. Folstein MF, Folstein SE, McHugh PR (1975) «Mini-mental state». A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 12:189–198

34. Knaus WA, Draper EA, Wagner DP et al (1985) APACHE II: a severity of disease classification system. Crit Care Med 13:818–829

35. Kalisvaart KJ, de Jonghe JF, Bogaards MJ, Vreeswijk R, Egberts TC, Burger BJ et al (2005) Haloperidol prophylaxis for elderly hip-surgery patients at risk for delirium: a randomized placebo-controlled study. J Am Geriatr Soc 53(10):1658–1666

36. Hetherington R (1954) The Snellen chart as a test of visual acuity. Psychol Forsch 24:349–357

37. Inouye SK, van Dyck CH, Alessi CA, Balkin S, Siegal AP, Horwitz RI (1990) Clarifying confusion: the confusion assessment method. A new method for detection of delirium. Ann Intern Med 1990 113(12):941–948

38. van den Boogaard M, Pickkers P, Slooter AJ, Kuiper MA, Spronk PE, van der Voort PH, van der Hoeven JG, Donders R, van Achterberg T, Schoonhoven L (2012) Development and validation of PRE-DELIRIC (PREdiction of DELIRium in ICU patients) delirium prediction model for intensive care patients: observational multicentre study. BMJ 9(344):e420

39. Fan H, Ji M, Huang J, Yue P, Yang X, Wang C, Ying W (2019) Development and validation of a dynamic delirium prediction rule in patients admitted to the Intensive Care Units (DYNAMIC-ICU): a prospective cohort study. Int J Nurs Stud 93:64–73

40. Kat MG, Vreeswijk R, de Jonghe JFM, van der Ploeg T, van Gool WA, Eikelenboom P, Kalisvaart KJ (2008) Long-term cognitive outcome of delirium in elderly hip surgery patients. Dement Geriatr Cogn Disord 26(1):1–8

41. Woodford HJ, George J (2007) Cognitive assessment in the elderly: a review of clinical methods. QJM 100:469–484