Aging Clinical and Experimental Research (2022) 34:2927–2944
https://doi.org/10.1007/s40520-022-02249-y

REVIEW ARTICLE

Recipe for primary prevention of delirium in hospitalized older patients

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Received: 15 February 2022 / Accepted: 3 September 2022 / Published online: 22 September 2022

Abstract

Delirium is an acute fluctuating syndrome characterized by a change in consciousness, perception, orientation, cognition, sleep–wake rhythm, psychomotor skills, and the mood and feelings of a patient. Delirium and delirium prevention remain a challenge for healthcare professionals, especially nurses who form the basis of patient care. It also causes distress for patients, their caregivers and healthcare professionals. However, delirium is preventable in 30–40% of cases. The aim of this article is to summarize the delirium risk models, delirium screening tools, and (non-pharmacological) delirium prevention strategies. A literature search of review articles supplemented by original articles published in PubMed, Cinahl, and Cochrane between 1 January 2000 and 31 December 2020 was carried out. Among the older patients, delirium is a common condition with major consequences in terms of mortality and morbidity, but prevention is possible. Despite the fact that delirium risk models, delirium screening scales and non-pharmacological prevention are available for the development of a hospital delirium prevention programme, such a programme is still not commonly used on a daily basis.

Keywords Delirium · Risk · Prediction · Prevention · Non-pharmacological

Introduction

Delirium is described in the DSM-5 as an acute fluctuating syndrome characterised by a change in consciousness, perception, orientation, cognition, sleep–wake rhythm, psychomotor skills, and the mood and feelings of a patient [1]. The delirium prevalence varies among hospital patient populations ranging from 5% for elective orthopaedic surgery to 87% for intensive care unit (ICU) patients [2, 3]. The causes of delirium vary, but there is almost always a somatic cause, putting frail and cognitively impaired patient and patients with multimorbidity at the highest risk of delirium [4–6]. Patients with delirium often have a risk of morbidity, mortality, prolonged hospital length of stay, high rates of institutionalization, and cognitive decline [7, 8]. Delirium is also associated with long-term cognitive decline [9]. Delirium increases the cost of the index hospitalization as well as the need for post-acute care and the demands on unpaid, often older caregivers [10, 11]. Delirium and delirium prevention continue to be a challenge for healthcare professionals, especially for nurses who form the basis of patient care. It also causes distress for patients, their caregivers, and healthcare professionals [12–14]. In 30–40% of cases, delirium is a preventable condition [15]. Prevention starts by patients at risk of delirium being identified using a delirium risk model, followed by management of these patients using delirium screening tools and non-pharmacological preventive interventions. Delirium prevention increases patient well-being, as well as decreasing staff workload and reducing costs. Nevertheless, several studies reveal a shortfall in nurses´ knowledge of delirium prevention, which has a negative impact on the number of appropriate outcomes. In addition, despite the fact that the knowledge from research on delirium detection, control and prevention is available, its application in daily practice can still be improved. [16–19]

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A successful implementation in daily practice starts with knowledge and the attitude of nurses and doctors.

The aim of this article is to summarize the delirium prediction models, screening tools, and the non-pharmacological prevention of delirium.

Data sources and search strategy

Search strategy

A literature search of review articles supplemented by original articles published in PubMed, Cinahl, and Cochrane between 1 January 2000 and 31 December 2020 was carried out. The published review articles were supplemented by the original articles that were not included in the reviews (Fig. 1). In addition, the reference list for additional studies in these articles was reviewed.

The Mesh terms and all field keywords per phase were:

Screening for Delirium risk and prediction:
Delirium, postoperative, hospital, prediction, model, risk*, older patient.
Assessment for delirium and preventive interventions:
Delirium, postoperative, hospital, prevention, non-pharmacology, screening, older patient.

Criteria for inclusion of articles

Articles for delirium risk were included if the authors had investigated risk assessment of delirium based on predisposing risk factors for delirium as the main purpose of the study and including older patients admitted to hospital. Only articles written in English were included. Reviews supplemented by original articles that were not in the reviews were also included. All study designs were included and

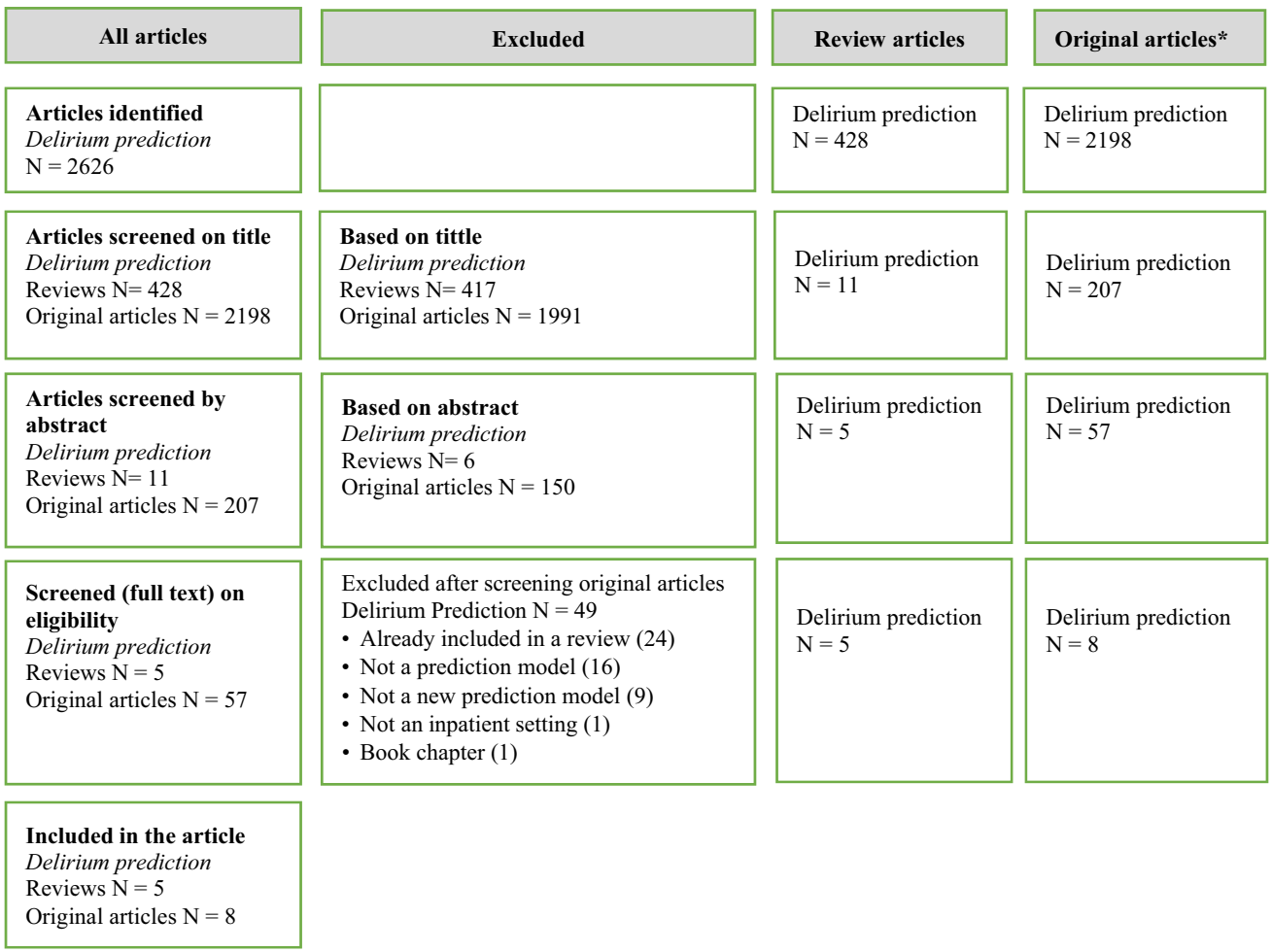

Fig. 1 Flowchart review articles supplemented with original articles Delirium Prediction Models. *Final inclusion were original articles not included in the found and used reviews

Table 1 Predisposing and precipitating risk factors for delirium [6]

Predisposing risk factors for delirium	Precipitating risk factors for delirium
Demographic and social factors	Medications
Older age	Substance withdrawal
Male gender	Alcohol
Institutional setting	Sedative hypnotics
Social isolation process of care	Substance intoxication
Iatrogenesis	Sedative hypnotics
Inadequate skills in recognition of delirium	Narcotics
Negative attitudes towards the care of the elderly	Anticholinergics
Rapid pace and technological focus of acute care	Antipsychotics
Reductions in skilled nursing staff	Antiparkinsonians
Special sensory impairment	Antidepressants
Visual impairment	Severe acute illness infections:
Hearing impairment	Urinary tract infections
Cognitive and psychiatric comorbidity	Pneumonia
Dementia	Metabolic abnormalities:
Degree of stage of dementia	Hyperglycaemia/hypoglycaemia
Late-onset Alzheimer's dementia	Hypercalcaemia/hypocalcaemia
Vascular dementia	Thyrotoxicosis/Myxoedema
Cognitive impairment	Adrenal Insufficiency:
Depression	Hepatic Failure
Functional impairments and disability	Renal Failure
Functional dependence	Hypernatremia/Hyponatremia
Immobility	Hyperkalaemia/Hypokalaemia
Fracture on admission	Hypoperfusion states and pulmonary compromise
Malnutrition:	Hypoxaemia
Dehydration	Shock
Alcoholism	Anaemia
Medical comorbidity	Congestive heart failure
Hugh burden of illness	Chronic obstructive pulmonary disease
Previous stroke	Urinary and faecal retention
Parkinson's disease	Environmental–psychological contributors
Azotaemia	Sensory deprivation
	Sensory overload
	Psychological stress
	Sleep deprivation
	Pain
	Physical restrain use
	Bladder catheter use
	Any iatrogenic event
	Intensive care unit treatment
	Surgery, anaesthesia and other procedures
	Orthopaedic surgery
	Cardiac surgery
	Duration of cardiopulmonary bypass
	Non-cardiac surgery
	High number of procedures in hospital
	Neurologic illness:
	Subdural hematoma
	Stroke
	Malignancy
	Cerebral infection
	Seizures

there was no limitation by time frame of delirium development. Studies were excluded if they study a patient population (emergency departments, palliative care or hospice) of which the results are not generalizable to a medical or surgical inpatient hospital setting. These specific patient populations have specific characteristics requiring specific care regarding delirium prevention. Furthermore, studies in populations related to alcohol withdrawal or delirium tremens were excluded. Titles and abstracts of the search results were reviewed for eligibility, followed by the full text of the paper by the author (RV) and any duplicates were removed. Where there was doubt, papers were assessed by another author (KK). Selected studies were then subject to a full text review, based on the inclusion and exclusion

criteria, ultimately resulting in a final list of included articles. The inclusion criteria were delirium, hospital, prevention (non-pharmacological), and screening. Exclusion criteria: non-hospital, delirium treatment.

Data items

Data were collected on the year of publication, study design, population, evaluation of delirium (screening and severity), delirium risk models, and (non-pharmacological) interventions for delirium prevention.

Results of the delirium risk models

Since the aetiology of delirium is multifactorial, predisposing factors on admission and precipitating factors during hospitalization vary and prediction models for delirium are numerous (Table 1). However, only a few models have been independently validated and implemented into clinical practice [20]. The literature search resulted in five review articles on delirium prediction models [21–25] and four original articles [26–29].

In total, 28 delirium prediction models were found of which 15 were validated in another patient population (Table 2). 23 articles were prospective cohort studies, 4 were retrospective cohort studies, and 1 was an observational study. Nine studies included internal medicine patients (internal (6), neurology (1), acute geriatric (1), cardiology (1)), 11 studies were surgical patient populations (elective non-cardiac (3), elective orthopaedic (2), hip fracture (3), elective cardiac (1), oncology (2)), 6 studies were a mixed population and 2 were ICU patient populations. The area under the curve (AUC) of the different delirium risk models varied in the development cohort from 0.72 to 0.91 with a range of 0.61– 0.94, and in the validation cohorts the AUC varied from 0.53 to 0.94 with a range of 0.42–0.97. Not all the delirium risk models had an AUC calculated [30–32]. The omission of an AUC makes it more difficult to compare the model with other models and more difficult to gain insight into the predictive value of the model. The models used varying combinations of risk factors for delirium with inconsistency in the definitions and measurements of these risk factors. The risk factors used were pre-existing cognitive disorders (20 models), sensory disorders (10 models), higher age (11 models), activities of daily life (ADL) problems (9 models), degree of illness (number of chronic diseases present) (9 models), abnormal laboratory values (7 models), infections present (6 models), alcohol/drug abuse (7 models) and prior delirium (6 models). Furthermore, the type of admission (acute), depression, malnutrition, and amount of medication before and during hospital admission were also risk factors. Some models also showed catheter use, acute surgery, fracture at admission, history of stroke, iatrogenic event, and ICU admission variables in the final model. Cognitive impairment in models were based on an MMSE screening, telephone interview for cognitive status (TICS), or clock-drawing score (Table 2). There are several limitations. Firstly, the research design, application, and reporting of statistical methods seem inadequate. The assessment of delirium varied both in method and personnel; the Confusion Assessment Method (CAM) was used most, but the screening moment, when mentioned, varied from three times a day to once every 48 h. Screening for delirium was done by nurses, doctors, or research personnel. The way of screening (time, method, and personnel) could have had consequences for delirium incidence, because there is a chance that delirium would have been missed due to symptoms varying during the day. Also, the incidence of delirium varied among retrospective and prospective studies. The retrospective design of studies may have consequences for the adequate diagnosing of delirium because of being less accurate. Only eight studies mentioned that the diagnosis of delirium was confirmed by a geriatrician, psychiatrist, psychologist, or independent screening of patient charts. Moreover, the models were developed for specific patient populations and therefore impeded the generalizability to other populations. Even if patient populations in different studies were the same (e.g. hip fracture), the inclusion and exclusion criteria were different per study which makes generalizability difficult.

Delirium screening and severity scales

Delirium is commonly overlooked or misattributed to dementia, depression, or senescence; confessional states in the hospitalized elderly are considered the rule rather than the exception, and cognitive function is rarely assessed [33]. Moreover, characteristics of the delirium itself, such as its fluctuating nature, lucid intervals and predominance of the hypoactive form in the older patients, make its recognition more difficult [33]. But two influential diagnostic classification systems exist. The Diagnostic and Statistical Manual for Mental Disorders (DSM) criteria of the American Psychiatric Association, with revised versions over the last decade (DSM-III, DSM-III-R, DSM-IV, DSM-IV-TR, and DSM-V) [34] and the International Classification of Diseases (ICD) version 11 [35]. Although differences between the systems appear to be small, some studies have pointed out that these differences can lead to diverging results in the recognition and diagnosis of delirium [36].

For prevention of delirium, it is necessary to look for patients "at risk" of delirium and to use instruments for screening and severity. Also, the medical and nursing staff should be made aware of prodromal symptoms for delirium, which indicate a delirium is developing. Most patients with

Table 2 Delirium prediction models

	Author Name of instrument Year Journal	Study design patient population N	Delirium screening Delirium incidence *N* (%)	Instrument variables		AUC
1	Inouye Model Inouye et al 1993 Ann Int. Med Rudolph et al Inouye model 2011	Prospective cohort Internal patients Age > 70 years Development cohort: 107 Validation cohort: 174 Prospective cohort Internal patients Validation cohort: 100	CAM, daily Development cohort: 27 (25) Validation cohort: 29 (17) DSM-IV, daily interview Development cohort: 23 (23)	Predisposing factors MMSE ≤ 24 > 16 Vision impairment20/70 High urea/creatinine ratio APACHE II > 16	1 point 1 point 1 point 1 point	No AUC calculation Validation cohort: AUC 0.53 (95% CI 0.42 – 0.74)
2	Risk stratification model Pompei et al 1994 JAGS	Prospective cohort Internal and surgical patients Age > 65 years Development cohort: 432 Validation cohort: 323	CAM, 2 × a week, confirmation according to DSM-III Development cohort: 64 (14.8) Validation cohort: 86 (26.3)	Cognitive impairment Comorbidity Depression Alcohol use		No AUC calculation
3	Marcantonio model Marcantonio et al 1994 JAMA	Prospective cohort Elective non-cardiologic surgery Age > 50 years Development cohort: 1341	CAM and patient file Development cohort:117 (9)	Alcohol abuse TICS Deviating lab (serum sodium, potassium, glucose) Aortic aneurysm surgery Non-cardiac/thoracic surgery		Development cohort: AUC 0.81
4	Two variables model Fisher and Flowerdew 1995 JAGS	Prospective cohort Elective orthopaedic Age > 60 years Development cohort: 80	CAM, 2 × daily Development cohort: 14 (17,5)	Clock-drawing score ≤ 6 Male gender		No AUC calculation
5	Risk stratification model O'Keeffe and Lavan 1996 Age Ageing	Prospective cohort Acute geriatric unit patients Development cohort: 100 Validation cohort: 84 Age not mentioned	DAS, every 48 h (DSM-III) Development cohort: 28 (28) Validation cohort: 25 (30)	Dementia Severe illness Raised serum urea		Development cohort: AUC 0.79 (95% CI 0.69–0.90) Validation cohort: AUC 0.75 (95% CI 0.63–0.86)
6	DEAR Freter et al 2005 Age ageing 2015 Can Geriatric Journ	Prospective cohort Hip fracture Development cohort: 132 Age ≥ 65 years Validation cohort: 283 Age ≥ 65 years	CAM, daily Development cohort:24 (24) CAM, day 1, 3 and 5 Validation cohort: 119 (42)	Age ≥ 80 years Cognitive impairment (MMSE < 24) Substance use (alcohol > 3/week or benzodiazepine > 3/week Sensory impairment Functional dependence (Need for ADL)		Development cohort: 0.77 (95% CI 0.64–0.87) Validation cohort No AUC calculation
7	Kalisvaart model Kalisvaart et al 2006	Prospective cohort Hip fracture patients Age > 65 years Validation cohort: 603	CAM, DRS-98, daily max 5 days after surgery confirmation by geriatrician Validation cohort: 74 (12)	Age Acute admission MMSE ≤ 24		-Validation cohort: -AUC 0.73 ((95% CI: 0.65 – 0.78)

Table 2 (continued)

	Author Name of instrument Year Journal	Study design patient population N	Delirium screening Delirium incidence *N* (%)	Instrument variables		AUC
8	Delirium Risk Checklist Koster et al 2008 Ann Thorac Surg Revised Delirium Risk Checklist Koster et al 2012 Eur. J. Cardiovasc. nursing	Observational cohort Elective cardiology Development cohort: 112 Age ≥ 45 years Elective cardiac surgery Validation (original version) and Development (revised version) cohort: 300 Age ≥ 45 years	DOSS and psychiatrist Development cohort: 24 (21) DOSS Development and validation cohort: 52 (17.3)	Delirium Risk Checklist original version Lab values: electrolyte sodium and potassium EURO score Revised Delirium Risk Checklist Higher EURO score Age ≥ 70 years Cognitive impairment (MMSE,23) Number of comorbidities History of delirium Alcohol use Type of surgery		-Development cohort: -AUC 0.75 (95% CI 0.66–0.85) Validation cohort original version: 0.75 (95% CI 0.66–0.85) Development cohort revised version: 0.89 (95% CI: 0.83 – 0.94)
9	Risk stratification model Rudolph et al 2009 Circulation	Prospective cohort Cardiologic surgery Age > 60 years Development cohort: 122 Validation cohort: 109	CAM, MDAS, DSI, daily Development cohort: 63 (52) Validation cohort: 48 (44)	Stroke of transient ischaemic attack in medical history MMSE ≤ 23 MMSE 24 – 27 GDS ≥ 4 Albumin divergent	1 point 2 points 1 point 1 point 1 point	-Development cohort: -AUC 0.74 -Validation cohort: -AUC 0.75
10	Risk Model for Delirium (RD) Vochteloo 2011 BMC Geriatr Moerman et al 2012	Prospective cohort Hip fracture Age > 65 years Development cohort 445 Prospective Cohort Hip fracture Age > 65 years Validation cohort: 378	DSM-IV Development cohort: 120 (27) Nursing observation 3 × daily Confirmed by chart review Validation cohort: 102 (27)	Earlier delirium Dementia Clock drawing Minor fault Major fault Hearing problem Vision problem ADL-problem: IADL impairment ADL impairment Use heroin, methadone, morphine Alcohol > 4 units	5 points 5 points 1 point 2 points 1 point 1 point 0,5 point 0,5 point 1 point 1 point	Development cohort: AUC 0.72 (95% CI 0.67–0.77) Validation cohort: AUC 0.73 (95% CI 0.68–0.77)
11	Risk stratification model Isfandiaty et al 2012 Acta Med Indonesia	Retrospective cohort Internal patients Age > 60 years Age > 60 years Development cohort: 457	Not known, daily Development cohort: 87 (19)	Infection (without sepsis) Cognitive impairment Decrease functional status		Development cohort: AUC 0.82 (95% CI 0.78–0.88)
12	Clinical Prediction model Martinez et al 2012 BMJ Open	Prospective cohort Internal patients Age > 18 years Development cohort: 397 Validation cohort: 302	CAM Development cohort: 53 (13) Validation cohort: 76 (25)	Age > 85 ADL > 5 Medication at admission Medication Antipsychotic	1 point 1 point 1 point 2 points	Validation cohort 1: AUC 0.85 (95% CI 0.80–0.88) Validation cohort 2: AUC 0.78 (95% CI 0.68 –88)

Table 2 (continued)

	Author Name of instrument Year Journal	Study design patient population N	Delirium screening Delirium incidence *N* (%)	Instrument variables	AUC
13	PREDELIRIC Boogaard et al 2012 BMJ	Prospective cohort ICU Age > 18 years Development cohort 1613 Validation cohort: 549	CAM-ICU, EPD patient, DSM-IV Development cohort: 411 (25.5) Validation cohort: 171 (31.1)	APACHE Reason for admission Coma Infection Metabolic acidosis Sedatives/morphine use Urea concentration Acute admission Age	Development cohort: AUC 0.87 (95% CI 0.85–0.89) Validation cohort: AUC 0.89 (95% CI 0.86–0.92) External validation: AUC 0.84 (95% CI 0.82–0.87)
14	AWOL Douglas et al 2013 J Hosp. Med	Prospective cohort Internal patients Age > 50 years Development cohort: 209 Validation cohort: 165	Short CAM, daily Development cohort: 25 (12) Validation cohort: 14 (8.5)	Age ≥ 80 World cannot spell backwards Disorientation in location Higher nurse-rated illness severity	Development cohort AUC 0.81(95% CI 0.73–0.90) Validation cohort AUC 0.69 (95% CI 0.54–0.83)
15	Predictive Risk Score Carrasco et al 2014 Age Aging	Prospective cohort Internal patients Age > 65 years Development cohort: 374 Validation cohort: 104	CAM, every 48 h Development cohort: 25 (0.06) Validation cohort: 12 (12)	Barthel Score Dehydration (urea/creatinine level)	Development cohort: AUC 0.86 (95% CI 0.82–0.91) Validation cohort: AUC 0.78 (95% CI 0.66–0.90)
16	Kennedy model Kennedy et al 2014 J. Am. Geriatr. Soc	Prospective observational cohort SHE Age > 65 years Development Cohort: 700	CAM Development cohort: 63 (9)	Age CVA or ischaemic attack in medical history Dementia Suspected infection Acute intracranial bleeding	Development cohort AUC 0.77 (95% CI 0.71–0.83)
17	Dutch Safety Management (VMS) Ettema et al 2018 Gen. Hosp. Psychiatry	Retrospective cohort Mixed population Age > 70 years Validation cohort: 3786	DOSS, review patient file on antipsychotics, notes from either geriatrician or psychiatrist Validation cohort: (16,8)	Dutch National Safety Program: 3 questions -1 point -1 point Did you need assistance in ADL 24 h before admission? -1 point Do you have memory problems? Have you experienced confusion during an earlier admission? Addition of more variables: Age Functional barriers (KATZ) Number of medications prescribed Vision problem	Validation cohort 3 question instrument AUC 0.81 (95% CI 0.79–0.83) Validation cohort extended AUC 0.86 (95% CI 0.84 –0.87)

Table 2 (continued)

	Author Name of instrument Year Journal	Study design patient population N	Delirium screening Delirium incidence *N* (%)	Instrument variables	AUC
18	CGA Korc-Grodzicki et al 2015 Ann Surg	Prospective cohort Oncological surgery Age > 75 years Development cohort: 416	CAM, daily Development cohort: 79 (19)	Charlson Comorbidity Index score ≥ 3 IADL = D Fall = yes Abnormal Mini-Cog	Development cohort: AUC 0.64
19	CGA Liang et al 2015 Rejuvenation	Prospective cohort Elective orthopaedic surgery Age > 60 years Development cohort: 461	CAM, daily, confirmed by psychologist (DSM-IV) Development cohort: 37 (8)	Comprehensive Geriatric Assessment: Polypharmacy Hearing impairment ADL (Barthel ≤ 75) Cognition (MMSE < 24) GDS-15 ≥ 5 Demographic factors: Age ≥ 75 Male CCI ≥ 2 Type of surgery (knee, hip spine)	No AUC calculation
20	CGA Maekawa et al 2016 Geriatric Gerontology Int	Prospective cohort Oncologic; gastrointestinal surgery Age > 75 years Development cohort: 517	CAM Development cohort: 124 (24)	Comprehensive Geriatric Assessment	No AUC calculation
21	DElirium MOdel (DEMO) De Wit et al 2016 Int. J. Clin. Pharm Gonzalvo et al 2017 BMJ Open	Retrospective cohort Mixed population Age > 60 years Development cohort: 1291 Observational Mixed population Age > 60 years Validation cohort: 383	Chart review Development cohort: 225 (17) Chart review Delirium screening on 1, 3 and 5 day Validation cohort: 98 (25.6)	Automated delirium prediction model CDSS - Age Polypharmacy Anxiolytics Anti-dementia Antidepressant Anti-Parkinson's agents Antidiabetic Psychopharmaca Analgetics Sleep medication	Development cohort: AUC 0.77 (95% CI 0.74–0.81) Validation cohort:
22	Mini-Cog Dworkin et al 2016 JAGS	Prospective cohort Elective non-cardiac surgery Age > 65 years Development cohort: 76	CAM of FAM-CAM, 1 × after operation Development cohort 10 (13)	Mini-COG	Development cohort: AUC 0.77 (95% CI 0.61–0.93)

Table 2 (continued)

	Author Name of instrument Year Journal	Study design patient population N	Delirium screening Delirium incidence *N* (%)	Instrument variables		AUC
23	DELPHI Kim et al. 2016 Medicine	Prospective cohort Major surgery Development cohort: 561 Validation cohort: 533	Nu-Desc: every shift by nurses' confirmation by CAM Development cohort: 112 (20) Validation cohort: 99 (18)	Age; 60– 69 70 – 79 ≥80 Low physical activity: Self-reliant Help needed Lots of alcohol; No Yes Hearing problem No Yes Earlier delirium No Yes Acute surgical No Yes Open surgical procedure No Yes ICU admission No Yes CRP (mg/dL) <10 ≥10	0 points 1 point 1 point 0 points 2 points 0 points 2 points 0 points 1 point 0 points 2 points 0 points 1 point 0 points 2 points 0 points 3 points 0 points 1 point	Development cohort AUC 0.91 (95% CI 0.88–0.94) Validation cohort AUC 0.94 (95% CI 0.91–0.97)
24	E-NICE risk Risk stratification model Rudolph et al. 2016	Retrospective cohort Development cohort: 27 625 Prospective cohort Validation cohort: 246 Internal and surgical population	Development cohort: audit patient File Val: DSM-IV Daily interview Development cohort: 2342 (8) Validation cohort: 64 (26)	Cognition Age: ≥65 year ≥80 year Infection Fracture Vision problem Severe illnesses	4 points 2 points 3 points 2 points 4 points 1 point 2 points	Development cohort: AUC 0.81 (95% CI 0.80–0.82) Validation cohort: AUC 0.69 (95% CI 0.61–0.77)
25	Pendlebury et al. 2017 Age Ageing	Prospective cohort Internal patients Age ≥ 65 years Validation cohort: 308	CAM, every 48-h confirmation by a DSM-IV-interview Validation cohort: 95 (31)	Age ≥ 80 years Cognitive problem Severe illness Infection Vision problem	2 points 2 points 1 point 1 point 1 point	Validation cohort: AUC 0.78 (95% CI 0.71–0.84)

Table 2 (continued)

	Author Name of instrument Year Journal	Study design patient population N	Delirium screening Delirium incidence *N* (%)	Instrument variables		AUC
26	DYNAMIC-ICU Fan et al 2019 Int. J. Nurs. Stud	Prospective cohort ICU patients: 560 Development cohort: 336 Validation cohort: 224	Development cohort: 68 (20.2) Validation cohort: 46 (20.5)	Predisposing factors: History of chronic illnesses Hearing impairment Illness-related factors: Infection High APACHE II score on admission Iatrogenic and environmental factors Use of sedatives and analgesics Indwelling catheter Sleep disturbance		Development cohort: AUC 0.91 (95%CI 0.87–0.94) Validation cohort: AUC 0.90 (95% CI 0.86–0.94)
27	PANDA Nakamizo et al 2020 J. Neurological Sciences	Prospective cohort 387 Development cohort: Acute stroke patients	Intensive Care Delirium Screening Checklist Development cohort: 42 (12.1)	Prior delirium Alcohol (> 40 g ethanol/day) Stroke severity (HIHSS ≥ 5) Dementia (diagnosed prior to admission) Auditory/visual impairment		Development cohort: AUC 0.84 (95% CI 0.78–0.89)
28	Delirium Risk Assessment Score (DRAS) Vreeswijk et al 2020 EUGM	Prospective cohort Development cohort: 842 Mixed population Validation cohort 1: 408 Orthopaedic population Validation cohort 2: 186 Surgical population Validation cohort 3: 365 Orthopaedic/surgical Age ≥ 70 years	CAM and geriatrician daily Development cohort:268 (31.8) Validation cohort 1: 83 (20.3) Validation cohort 2: 28 (15.1) Validation cohort 3: 57 (15.6)	Acute admission Cognitive impairment Alcohol abuses > 4 units ADL impairment Vision/hearing impairment Earlier delirium Medication 5 of more Age ≥ 75	3 points 3 points 3 points 2 points 1 point 1 point 1 point 1 point	Development cohort: AUC 0.75 (95% CI 0.79–0.58) Validation cohort 1: AUC 0.75 (95% CI 0.71–0.72) Validation cohort 2: AUC 0.78 (95% CI 0.60–0.89) Validation cohort 3: AUC 0.75 (95% CI 0.67–0.74)

MMSE: Mini Mental State examination

CAM Confusion Assessment Method, *ADL* activities of daily living, *GDS* Geriatric Depression Scale, *TICS* telephone interview for cognitive status, *EPD* electronic patient chart

Table 3 Delirium Screening and Severity Scales

Scale	Year	Type of Scale	Examiner	Time	DSM	Cognitive test	Training	DSM criteria					Ward
								Acute onset	Fluctuating course	Inattention	Disorientation	Cognitive impairment	
Delirium Symptom Interview (DSI)	1992	Screening	Clinician	10–15 min	DSM-III	No	Yes	No	Yes	Yes	Yes	No	Non-ICU
Saskatoon Delirium Checklist (SDC)	1988	Screening	Clinician	5 min	DSM-III	No	Yes	Yes	Yes	Yes	Yes	Yes	Non-ICU
Visual analogue scale for acute confusion (VAS-AC)	1986	Screening	Nurses	5 min	?	No	Yes	No	No	Yes	Yes	No	Non-ICU
Confusion Assessment Method (CAM)	1990	Screening	Clinician	5–10 min	DSM-IV	Yes	Yes	Yes	Yes	Yes	Yes	No	Non-ICU
Clinical Assessment of Confusion–A and B (CAC-A and B)	1990	Screening	Nurses	10 min	DSM-III	Yes	Yes	No	No	No	Yes	Yes	Non-ICU
Confusion Rating Scale (CRS)	1991	Screening	Nurses	1–2 min	?	No	Yes	No	Yes	Yes	Yes	No	Non-ICU
Delirium Symptom Interview (DSI)	1992	Screening	Clinician	1–2 min	DSM-III	No	Yes	No	Yes	Yes	Yes	No	Non-ICU
Cognitive Test for Delirium (CTD)	1996	Screening	Clinician	10–15 min	DSM-III	Yes	Yes	No	No	Yes	Yes	Yes	ICU
Neelon and Champagne Confusion scale (NEECHAM)	1996	Screening	Clinician	3 min	DSM-IV	No	Yes	No	Yes	Yes	Yes	No	Non-ICU
Delirium index (DI)	1998	Screening	Clinician	10 min	DSM-III	Yes	Yes	No	No	Yes	Yes	Yes	Non-ICU
Intensive Care Delirium Screening Checklist (ICDSC)	2001	Screening	Nurses	10–15 min	DSM-IV	No	Yes	No	Yes	Yes	Yes	No	ICU
Delirium Observation Screening Scale (DOS)	2003	Screening	Nurses	5 min	DSM-IV	No	Yes	No	No	Yes	Yes	No	Non-ICU
Nursing Delirium Screening Scale (Nu-DESC)	2005	Screening	Nurses	1–2 min	DSM-IV	No	Yes	No	No	Yes	Yes	No	Non-ICU
Single Question for Delirium	2010	Screening	Nurses	< 5 min	DSM-IV	No	No	No	No	No	Yes	No	Non-ICU
4-A's test (4-AT) rapid clinical test for delirium	2011	Screening	Clinician	< 2 min	DSM-IV	Yes	No	Yes	No	Yes	Yes	Yes	Non-ICU
Confusion Assessment Method-ICU (CAM-ICU)	2011	Screening	Clinician	2–3 min	DSM-IV	Yes	Yes	Yes	Yes	Yes	Yes	No	ICU
Delirium Triage Screen (DTS)	2013	Screening	Clinician	< 1 min	DSM-IV	No	Yes	No	No	Yes	No	No	Non-ICU
Informant Assessment of Geriatric Delirium (IAGeD)	2013	Screening	?	5 min	DSM-IV	No	No	Yes	No	Yes	Yes	No	Non-ICU
3D-Confusion Assessment Method (3D-CAM)	2014	Screening	Clinician	1 min	DSM-IV	Yes	Yes	Yes	Yes	Yes	Yes	No	Non-ICU

Table 3 (continued)

Scale	Year	Type of Scale	Examiner	Time	DSM	Cognitive test	Training	DSM criteria					Ward
								Acute onset	Fluctuating course	Inattention	Disorientation	Cognitive impairment	
Stanford Proxy Test for Delirium (S-PTD)	2018	Screening	Clinician	< 1 min	DSM-V	No	Yes	Yes	Yes	Yes	Yes	No	Non-ICU
Ultra-Brief Confusion Assessment Method (UB-CAM)	2020	Screening	Clinician	< 1 min	DSM-V	Yes	Yes	Yes	Yes	Yes	Yes	No	Non-ICU
Delirium Assessment Scale (DAS)	1994	Severity	Clinician	?	DSM-III	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Non-ICU
Memorial Delirium Assessment scale (MDAS)	1997	Severity	Psychiatrist	< 30 min	DSM-IV	Yes	Yes	No	No	Yes	Yes	Yes	Non-ICU
Confusion State Evaluation (CSE)	1997	Severity	Clinician	< 30 min	DSM-III	No	Yes	Yes	Yes	Yes	Yes	No	Non-ICU
Delirium Index (DI)	1998	Severity	Clinician	10 min	DSM-IV	Yes	Yes	No	Yes	Yes	Yes	No	Non-ICU
Delirium Severity Scale (DSS)	1998	Severity	Clinician	10 min	?	Yes	Yes	No	No	Yes	No	No	Non-ICU
Delirium Rating Scale-Revised-98 (DRS-R-98)	2001	Severity	Clinician	20–30 min	DSM-IV	No	Yes	Yes	Yes	Yes	Yes	Yes	Non-ICU
Delirium-O-Meter (DOM)	2005	Severity	Nurses	3–5 min	DSM-IV	No	No	No	No	Yes	Yes	Yes	Non-ICU
Delirium Detection Score (DDS)	2005	Severity	Nurses	?	DSM-IV	No	Yes	No	No	No	Yes	No	ICU
Confusion Assessment Method-severity scale (CAM-S)	2014	Severity	Clinician	< 5 min	?	Yes	Yes	Yes	Yes	Yes	Yes	No	Non-ICU

Time: time to perform,

DSM: on which DSM version the scale is based

Cognitive test needed (yes or no)

Observation time necessary (yes or no)

Patient: screening done with or without patient

Training necessary (yes or no)

DSM criteria incorporated in scale (yes or no)

postoperative delirium already have early symptoms in the prodromal phase of delirium. These findings are potentially useful for screening purposes and optimizing prevention strategies targeted at reducing the incidence of postoperative delirium [37]. Early symptoms can be detected by the use of assessment scales for the recognition and diagnosis of delirium.

Several delirium screening and severity scales for hospital inpatients are described in different review articles [38–44] (Table 3). The scales can be divided into screening scales for the detection of delirium and severity scales for measuring the severity of delirium. In total, 21 delirium screening scales were found and 9 severity scales which can be used in hospitals. The first screening scale was published in 1992 and the first severity scale in 1994 (Table 3).

The delirium screening scales are: Delirium Symptom Interview (DSI), Saskatoon Delirium Checklist (SDC), Visual Analog Scale for Acute Confusion (VAS-AC), Confusion Assessment Method (CAM), Clinical Assessment of Confusion–A and B (CAC-A and B), Confusion Rating Scale (CRS), Delirium Symptom Interview (DSI), Cognitive Test for Delirium (CTD), Neelon–Champagne Confusion Scale (NEECHAM), Delirium Index (DI), Intensive Care Delirium Screening Checklist (ICDSC), Delirium Observation Screening Scale (DOS), Nursing Delirium Screening Scale (Nu-DESC), Single Question for Delirium, 4-A's Test (4-AT), Confusion Assessment Method-ICU (CAM-ICU), Delirium Triage Screen (DTS), Informant Assessment of geriatric delirium (IAGeD), 3D-Confusion Assessment Method (3D-CAM), Stanford Proxy Test for Delirium (S-PTD), Ultra-Brief Confusion Assessment Method (UB-CAM).

The delirium severity scales are: Delirium Assessment Scale (DAS), Memorial Delirium Assessment Scale (MDAS), Confusion State Evaluation (CSE), Delirium Index (DI), Delirium Severity Scale (DSS), Delirium Rating Scale-Revised-98 (DRS-R-98), Delirium-O-Meter (DOM), Delirium Detection Score (DDS), Confusion Assessment Method-severity scale (CAM-S).

Three delirium screening scales can be used as a diagnostic scale: Confusion Assessment Method (CAM), Delirium Rating Scale-Revised-98 (DRS-R-98), and Memorial Delirium Assessment Scale (MDAS) [45].

Many of the scales mentioned have not been implemented into daily practice or outside the centres where they were developed. Furthermore, it is noted that most scales are only used in research regarding delirium in specific patient populations. The exceptions are the CAM, CAM-ICU, DOSS, NEECHAM, DRSR-98, MDAS, and the 4AT. The content of a scale is closely related to its theoretical background, in most cases the DSM delirium criteria. However, this classification system itself has been developed further over the years and also the rating scales are based on DSM-III, DSM-IV, or DSM-V. Consciousness or attention disturbances are considered core delirium symptoms. All scales have one or more items for measuring these symptoms. Also, they all contain items registering, to some extent, and cognitive changes, such as memory, language, thinking, and perception disorders. Considering these cognitive aspects, it is important that a (screening) scale distinguishes between delirium and other psychiatric disorders such as dementia or depression.

The delirium screening scales are developed for doctors, nurses, psychologists or psychiatrists. Nine of the screening scales and four of the severity scales use cognitive screening scales such as MMSE, clock drawing, and months of the year backwards. The time taken varies from less than 1 min to up to 30 min. Some scales, however, need time for a patient to be observed during shifts (e.g. CRS, DOSS) or for all the information to be gathered (e.g. chart review, physical tests) (e.g. NEECHAM). No training is needed for three screening scales (IAGed, 4-AT, Single Question for Delirium) and one severity scale (DOM). Only two scales (IAGed, Single Question for Delirium) get the information from a source other than the patient.

Non-pharmacological strategies for the prevention of delirium

The majority of studies that investigated non-pharmacological prevention of delirium were designed as explanatory studies with the aim of demonstrating the efficacy of the intervention. No intervention or group of interventions reliably prevents delirium, but there are a number of non-pharmacological interventions aimed at predisposing and precipitating risk factors of delirium that appear to reduce the incidence [46–48].

A research article by Abraha (2015) describes 16 prevention studies which studied single or multi-component interventions, organization of care, or the effect of education. In this article, only four randomized clinical trials, four clinical controlled trials, and eight before and after studies were found on the prevention of delirium. The overall conclusion was that in older patients, multi-component non-pharmacological interventions as well as some single-component interventions were effective in preventing delirium [49]. Other reviews came to the same conclusion. Martinez's review (2015) found seven studies of differing quality. The overall conclusion was that a multi-component intervention strategy reduced delirium incidence (relative risk 0.73, 95% confidence interval 0.63–0.85, $P < 0.001$) and there was no difference in the effectiveness with regard to the department or degree of dementia. An additional advantage of a multi-component strategy was that the number of fall incidents also decreased during hospitalization [48]. The

Zhang review (2013) demonstrated that a multi-component intervention strategy from the two randomized clinical trials found could prevent delirium. One of the RCTs belonged to Marcantonio, and he demonstrated that the reduction could be as high as 40% due to proactive geriatric consultation in hip fracture patients [50]. A systematic review and meta-analysis that identified 14 high-quality trials showed that a bundle of non-pharmacological and multi-component interventions decreased the incidence of delirium by 44% [51]. Wang's review about the use of comprehensive geriatric assessment (CGA) for the prevention of perioperative delirium in hip fractures, in which six RCTs and one quasi-RCT were investigated, concluded that CGA may provide a reduction in delirium incidence. As Wang indicates, the outcome should be used with some restraint [52]. The review and meta-analysis by Ludolph (2020) also found eight studies and the conclusion, in line with the current guidelines, was that multi-component interventions are effective in preventing delirium [53].

Although all the review articles mentioned that the quality of the studies are diverse, the overall conclusions were the same, namely that non-pharmacological interventions for the prevention of delirium are effective.

Non-pharmacological treatment involves providing an unambiguous, supportive environment to improve the orientation and maintain the competence of the patients. The components of non-pharmacological prevention can be divided into providing support and orientation, providing an unambiguous environment, measures at maintaining competence, and providing other supportive measures. Several non-pharmacological interventions consist of an orientation plan, therapeutic activities, sleep enhancement, (early) mobilization, a vision and/or hearing protocol, encouraging fluid intake, feeding assistance, family involvement, or an individual care plan. Possible interventions for the prevention of delirium are shown in Table 4.

Implications for daily practice

Twenty years ago, Inouye described the high incidence of delirium in hospitals as a prototypical symptom of the weaknesses in our hospital care, a combination of iatrogenic incidents, overmedication, failure to perform proper geriatric assessment, reduction of skilled nursing staff, rapid pace of care, and poor attitude when it comes to caring for elderly patients [54, 55]. More than 20 years after Inouye's conclusion, there are more and more improvements in the care for the prevention of delirium in hospitals, but still not enough. More guidelines are developed, and the construction and implementation of a delirium prevention programme makes it possible to provide the best possible care for patients either at risk of or with incident delirium. A delirium prevention programme requires prediction of risk of delirium, the use of cognitive and delirium assessment scales, and non-pharmacological preventive interventions.

To assess whether a patient is at risk of delirium, this review showed that there are already 28 delirium prediction models based on different risk factors for delirium and developed for different patient populations. It is because of this diversity that it is not possible to give a statement about which is the best prediction model to use in daily practice. It is difficult because of the difference in quality of the research, the variables used for the model, and the groups for which the model was developed. Despite the fact that more and more prediction models based on (evidence based) risk factors for delirium have been developed for different patient groups, the use of prediction models in daily practice is not yet common. A small survey on knowledge and attitude towards delirium amongst European delirium specialists gave no information about the use of delirium prediction models in daily practice [56]. Also, no study was found about the use of delirium prediction models in daily practice. Even so, the use of a prediction model for delirium in patients by forming 'at-risk' groups on the basis of higher vulnerability for delirium gives healthcare workers the opportunity to provide extra, high-cost preventive care to those who really need it.

By identifying the early symptoms in the prodromal phase of delirium using a delirium screening instrument, an early diagnosis can be made, and both doctors and nurses can focus more on detecting and preventing delirium. Most of the screening scales developed are easy to use, reliable, and validated, and some of them have already been translated into several languages. Furthermore, it is potentially useful for optimizing prevention strategies targeted at reducing the incidence of postoperative delirium. The most validated and used screening scales in daily practice are the CAM, DOSS, and CAM-ICU. However, the use of a screening scale in daily practice is not common despite that several screening scales are available. A study done amongst healthcare workers in different European countries showed that only 26% of these healthcare workers always use a scale to assess delirium. Most of the time, the CAM (52%) or the DOS (30%) is used [56]. Sinvani´s study found that only 50.3% of the participants indicated that a formal scale like the CAM should be used. Also, clinicians who had undergone delirium training were more confident about using delirium scales (59.3% vs 32.3%) [57]. Amongst UK doctors, there was some improvement in the use of a validated delirium assessment scale, as in 2006 only 9% used such a scale, but this increased to 35% in 2016 [58, 59]. Screening routinely varied from 26.8% to 59%. There is also a variation in daily use of the scale for screening. Routine screening was done once a day (23.6–54%), or once per shift (11.1–12%), depending on the situation [56, 60, 61].

Table 4 Non-pharmacological interventions for prevention of delirium (for nurses)

Risk factor		Intervention	
1	Orientation	Well-known objects from home (e.g. pictures)	A
		Bed at window side/corner side/appropriate lighting	D
		Clock, calendar	A
		Passing by, short conversation, introduce yourself	D
		Orientation/test, give information	D
		If room is too lively for this patient—1- or 2-person room	A
		- Same nurse constantly	A
2	Cognitive problems MMSE < 25	Appropriate lighting, nightlight on	A
		Regular visits from family and friends	D
		Detailed orientation conversation (who, what, why, where)	D
		Nurse tells who she is, why she comes, and what she is doing	A
3	Mobility	Encourage early mobility (e.g. walk, exercises, physiotherapy)	D
		Remove CAD/infuse/drain a.s.a.p	D
		Day schedule for mobilization (rather often and shorter out of bed)	D
		Avoid restraints	A
4	Senses -Hearing - Sight	Screening for visual and hearing impairment	A
		Address sensory impairment by resolving any reversible cause of impairment (e.g. impacted earwax)	A
		Are hearing aids available and working and used by the patient?	A
		Are visual aids available and used by the patient?	A
		Approach the patient from his/her best side	D
5	Intake -Fluid -Nutrition	Stimulate fluid intake by encouraging the patient to drink	D
		If patient is dehydrated, consider infusion and fluid balance	A
		Address poor nutrition (using SNAQ, MNA)	A
		Stimulate food intake	D
		Bad intake—consult a nutritionist	A
6	Pain	Address pain by using instruments (e.g. VAS)	D
		Looking for non-verbal signs of pain	D
		Initiate and reviewing appropriate pain management	A
		If pain medication, then attention for side effects	D
7	Sleep	Promote good sleep patterns and sleep hygiene by	A
		-Avoiding nursing procedures during sleep hours	A
		-Avoiding medical procedures during sleep hours	A
		-Reducing noise to a minimum during sleep hours	A
		-Scheduling medication rounds to avoid sleep disturbance	
		Stimulate activity during the daytime	D
		If possible, out of bed and mobilize the patient	D
		Use patient's rituals before going to sleep	D
		Use sleep medication (only if necessary)	A
8	Micturition and defaecation	Echo for bladder retention	A
		Attention for constipation, ask for defaecation	D
9	Patient	Educate patient at risk	A
		Inform patient about delirium prevention	A
10	Family	Inform family about delirium prevention and involve them if necessary in delirium prevention interventions	A
11	Other	Educate each other /staff	A
		Use delirium risk assessment model and delirium screening tool	D
12	Patient	Educate patient at risk	A
		Inform patient about delirium prevention	A

D daily checked/to do, *A* point of attention

Non-pharmacological strategies are often applied for the prevention and management of delirium. By providing a good standard of basic care, it is possible to prevent most types of delirium and reduce overall delirium incidence in hospitals. When educating students or nurses on the subject of the prevention of delirium, the standard reaction is always: "this seems such basic normal care". With the increasing numbers of old and above all frail patients in hospital, the first thing to do is provide good normal care. A delirium prevention programme must be a combination of multi-factor intervention (which is the best way for the prevention of delirium), and a proactive consultation team (doctors and nurses) seems to have the best results concerning the prevention of delirium. However, there is a difference in how non-pharmacological preventive interventions are applied. Overall, despite strong evidence supporting their value, the implementation of delirium preventive measures is still not a common practice and varies in different places. The main barriers to implementation include time constraints on the staff and cultural gaps among physicians and nurses [62, 63]. In addition, a lack of knowledge and attitude create a barrier. A survey amongst European delirium specialists showed that in hyperactive delirium, 60.6% combined pharmacological and non-pharmacological strategies, 30% used only non-pharmacological interventions and 9.4% used only pharmacological management. In hypoactive delirium patients, a non-pharmacological intervention approach was more common (67.5%), followed by a combination of non-pharmacological and pharmacological (29.4%) and pure pharmacological treatment (3%) [56]. A survey in Italy showed similar or lower figures. Only 11.1% of the nurses performed preventive non-pharmacological interventions [64].

Although the overall picture on delirium prevention is somewhat negative, it also offers a perspective on opportunities to improve the quality of hospital care for older people. The scales and preventive interventions are already available for the development of a hospital delirium prevention programme. As Inouye already showed in the Hospital Elderly Life Program (HELP), the implementation of a delirium risk assessment and prevention programme results in a decrease in incidence of delirium [55]. The expected significant benefits of delirium prevention are the reduction in complications, related medical costs, and the reduction in duration of hospital admission resulting from a reduction of delirium incidence and its severity [54, 55]. An improvement in nurses´ and doctors´ knowledge about the different aspects of delirium prevention leads to better preventive care for delirium [57, 58, 64, 65].

In summary, delirium is a common and dangerous condition in older adults, but—as Inouye said in 2000—prevention is possible. This article on the development of delirium risk models, screening scales, and non-drug prevention demonstrates that all necessary tools are in place for the development of a hospital delirium prevention programme. There is no reason whatsoever for any hospital not to implement all available knowledge into practice and to allow patients to benefit from it. Despite the fact that it is difficult to identify a single "best" device or "best"(multicomponent) non-pharmacological intervention. Also because there is a lack of calibration and classification measures between the included risk model studies, as well as the lack of consistency between risk models developed in different clinical settings.

Funding No financial support was received for this study.

Declarations

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

Ethical approval This article does not contain any studies with human participants or animals performed by the authors.

Informed consent For this study no informed consent is needed.

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