This manuscript has been published by Springer in European Geriatric Medicine and can be found here: <https://link.springer.com/article/10.1007/s41999-019-00278-x>

Reference: Lee, S.Y., Fisher, J., Wand, A.P.F. Milisen, K., Detroyer, E., Sockalingam, S., Agar, M., Hosie, A., Teodorczuk, A. Developing delirium best practice: a systematic review of education interventions for healthcare professionals working in inpatient settings. *Eur Geriatr Med* 11, 1–32 (2020). <https://doi.org/10.1007/s41999-019-00278-x>

Developing delirium best practice: A systematic review of education interventions for healthcare professionals working in inpatient settings

AUTHORS:

Song Yuin Lee¹, James Fisher², Anne P. F. Wand^{1,3}, Koen Milisen^{4,5}, Elke Detroyer^{4,5}, Sanjeev Sockalingam⁶, Meera Agar,⁷ Annmarie Hosie⁷, Andrew Teodorczuk^{8,9}

AFFILIATIONS

- 1) Department of General Medicine, Sutherland Hospital and Community Services, Sydney, Australia
- 2) Northumbria Healthcare NHS Foundation Trust, United Kingdom
- 3) Discipline of Psychiatry, School of Medicine, University of New South Wales, Sydney, Australia
- 4) Department of Public Health and Primary Care, Academic Centre for Nursing and Midwifery, KU Leuven, Leuven, Belgium
- 5) Department of Geriatrics, University Hospitals Leuven, Leuven, Belgium
- 6) Centre for Addiction and Mental Health, University of Toronto, Toronto, Canada
- 7) University of Technology Sydney, IMPACCT, Ultimo, Australia
- 8) School of Medicine, Griffith University, Gold Coast, Australia
- 9) The Prince Charles Hospital, Metro North Mental Health, Brisbane, Australia

Email Addresses:

- Song.Lee@health.nsw.gov.au
- drjamesfisher@hotmail.com
- Anne.Wand@health.nsw.gov.au
- koen.milisen@kuleuven.be
- elke.detroyer@kuleuven.be
- Sanjeev.Sockalingam@uhn.ca
- Meera.Agar@uts.edu.au
- Annmarie Hosie <Annmarie.Hosie@uts.edu.au>
- a.teodorczuk@griffith.edu.au

Key Summary points

Aim

To systematically review the quality, impact and sustainability of education interventions that focus on improving delirium care by healthcare professionals working in inpatient settings.

Findings

In general, though there was variability in the quality of the 42 educational studies identified, many were of good quality with 17 high quality studies (Kmet >80%) and four very high-quality studies (Kmet over >90%).

Overall studies were positive with thirty-seven studies (88%) reporting improved outcomes post-intervention. There was evidence of impact on patient and healthcare outcomes as well as learners' behaviour and knowledge.

Only thirteen studies measured intervention sustainability with variable impacts.

Message

The evidence base for education as an effective non-pharmacological approach to prevent and treat delirium is robust.

Further research is needed to determine sustainability of the approaches and understand effective implementation strategies to translate education research into practice.

ABSTRACT 250 words

Purpose

Understanding the quality of evidence of delirium education studies will assist in designing future education interventions that seek to improve the significant deficits in delirium prevention, detection and care.

The aim of this study is to systematically review the methodological strengths and limitations, as well as the impact, of delirium educational interventions for healthcare professionals working in inpatient settings.

Methods

MEDLINE, EMBASE, The Cochrane Library, PsychINFO and CINAHL databases were searched according to PRISMA guidelines for delirium educational interventions in hospital inpatient settings. Identified studies were rated using a standardised quality assessment criteria checklist (Kmet), and reported outcomes were organised by level on the Kirkpatrick model for educational outcomes.

Results

1354 papers were screened, of which 42 studies met the inclusion criteria. Interventions delivered included face to face education (n=34), e-Learning (n=8) and Interprofessional Education (n=8). Quality of studies varied in Kmet score (14-96%). There were 17 high quality studies (Kmet >80%) and four very high-quality studies (Kmet over >90%). Thirty-seven studies (88%) reported improved outcomes post-intervention. In terms of Kirkpatrick level of educational outcomes, six studies were rated at level 1; 13 studies at level 2; 15 studies at level 3; and eight studies at level 4. Thirteen studies measured intervention sustainability with variable impacts.

Conclusions

Given the relatively high number of good quality studies and that most demonstrated improved outcomes post-intervention, we conclude healthcare professional education has benefits in inpatient delirium care. Sustainability of educational interventions warrants further exploration.

Keywords: delirium, education, professional, hospital, training, teaching

BACKGROUND

Delirium occurs in approximately one in every five in-patients, making it the most common hospital complication today (1, 2). Delirium is not only distressing for the person and their carers, but it negatively impacts health and financial outcomes. Patients with delirium have increased length of stay, rates of institutionalisation, and mortality (3, 4). Furthermore, delirium accelerates cognitive decline in patients with dementia and is also a risk factor itself for dementia (5).

Despite its importance, healthcare staff frequently fail to recognise delirium (6) with non-detection rates as high as two thirds (7). Contributing reasons for non-detection include insufficient knowledge of delirium, a lack of widespread screening, the use of imprecise terms such as “confusion” and heterogeneous presentation of delirium (8). Compounding this problem is the fact that delirium is preventable, with the evidence base for prevention being stronger than treatment (9-11). A greater understanding and implementation of preventative strategies could reduce the incidence of delirium and its associated complications.

Approaches that seek to increase awareness of delirium and train healthcare professionals in best practice delirium care have the potential to reduce these negative health and financial outcomes and alleviate patient and carer distress. Educational interventions have been shown to prevent delirium (12), promote behavioural change that drives increased recognition (13) and reduce medication use (14). Qualitative studies of practice gaps have suggested that, in order to succeed, education interventions should target attitudes towards patients with delirium, adopt an interprofessional education (IPE) approach to learning where feasible, and align learning with organisational needs and priorities (15, 16).

To date, there have been four reviews of delirium education (17-20). These reviews noted the paucity of randomised controlled trials and the lack of detailed description of the educational component of some interventions, as many interventions were multi-component in nature (20). The previous reviews did not evaluate the long-term sustainability of the effect of the intervention. Moreover,

analysis of the quality of included studies has also been lacking, as reviews have focused on impact, often defined by Kirkpatrick level.

The purpose of this study is to evaluate the published literature reporting investigations of delirium educational interventions in inpatient settings, in terms of impact and importantly sustainability and methodological quality. The research questions were: 1) What impact do delirium educational interventions for inpatient healthcare professionals have upon their knowledge and behaviour, patient (health) outcomes and organisational outcomes? 2) What is the evidence that benefits are sustained over time? 3) What is the quality of studies of delirium educational interventions?

METHODS

Article inclusion and data analysis followed PRISMA guidelines (21). Covidence (22) was used to facilitate the review process, since it enabled central storage of all data and collaboration between authors.

Search Strategy

A systematic review of the English language literature was conducted using the electronic databases MEDLINE, EMBASE, The Cochrane Library, PsychINFO and CINAHL from the past 10 years (from January 2007 to December 2017). This process was repeated in March 2018. Search terms were “delirium”, “acute brain syndrome”, “organic brain syndrome”, “education”, “training”, “teaching”, “learning”, “e-learning”, “interprofessional” and “hospital”. Abstracts were screened, and studies were selected if they met the eligibility criteria. The full texts of included abstracts were then reviewed. Reference lists of the identified publications were also checked to identify additional eligible studies.

Inclusion/exclusion criteria

Research articles were included if they: a) were based in inpatient settings, including casualty/emergency departments, inpatient wards, intensive care units, palliative care units and hospices; b) were in English; c) evaluated an educational intervention as a core element; d) focused

upon an aspect of delirium care (detection, prevention or management); e) targeted post-qualification healthcare professionals who were working in inpatient clinical settings.

Articles were excluded if they: a) were based in outpatient areas, i.e. home, supported accommodation, aged care facilities and community services; b) did not describe the education intervention employed; c) did not involve inpatients with delirium; d) did not target healthcare professionals (for example, focusing upon pre-qualification students). Systematic reviews, qualitative studies and commentaries were excluded from the review.

Data extraction and quality / impact appraisal

Duplicate citations were removed, and the titles and abstracts were screened for inclusion independently by two researchers (SL, JF). Full text articles of the relevant abstracts were obtained and then subjected to independent review by two researchers (SL, JF). Any discrepancies regarding article inclusion were resolved via review by co-authors (AT, AW).

For each included study, the following data was extracted using a standardised data extraction form:

1) general study information (country of origin, clinical setting, study design, study aims, method(s) employed); 2) educational intervention (study population, details of the nature of the intervention); 3) reported outcomes (study results, sustainability); 4) quality of study information (assessment of methodological quality).

Studies were classified using the Alberta Heritage Foundation for Medical Research Standard Quality Assessment Criteria for quantitative research (hereafter referred to as Kmet, the publication's first author) (23). This scoring system provides an established framework for critically appraising the quality of education literature and has been used previously to evaluate robustness of studies of IPE in dementia care (24).

The Kmet quality assessment criteria are listed in Box 1. Scores range from 0 to 2 for each item (Yes = 2, Partial = 1, No = 0). The scores for each study are calculated and the total score (out of 28) is then

expressed as a percentage, with higher values indicating better methodological quality. Where items are deemed not applicable (n/a) to a given study (for example item 6, as blinding may not have been possible) the total possible score is amended accordingly i.e. total possible score = 28 – (number of “n/a” multiplied by 2). We defined studies with a score of $\geq 90\%$ as very high quality and those with a score of $\geq 80\%$ as high quality.

Box 1: Constituent items of the Kmet quality criteria (23)

Number	Quality criteria
1	Question / objective sufficiently described?
2	Study design evident and appropriate?
3	Method of subject/comparison group selection or source of information/input variables described and appropriate?
4	Subject (and comparison group, if applicable) characteristics sufficiently described?
5	If interventional and random allocation was possible, was it described?
6	If interventional and blinding of investigators was possible, was it reported?
7	If interventional and blinding of subjects was possible, was it reported?
8	Outcome and (if applicable) exposure measure(s) well defined and robust to measurement/misclassification bias? Means of assessment reported?
9	Sample size appropriate?
10	Analytic methods described/justified and appropriate?
11	Some estimate of variance is reported for the main results?
12	Controlled for confounding?
13	Results reported in sufficient detail?
14	Conclusions supported by the results?

Data pertaining to the type and impact of the education interventions on staff performance and patient outcomes were extracted. The included studies were secondarily assessed according to their respective outcome types using the Kirkpatrick model - Level 1: reaction (i.e. participant satisfaction), Level 2: learning (changes in healthcare professionals’ knowledge, skills and attitudes), Level 3: behaviour (changes in healthcare professionals’ practice), Level 4: results (changes in health outcomes) (25). The Kirkpatrick model is an approach to determine the impact of an educational intervention from the lowest level of a simple change in learner satisfaction (level 1) to a change in healthcare outcomes (level 4). Studies with outcome types across more than one level were placed in the highest

level. The sustainability of the effects was defined as the period during which the effects of the intervention were still detectable.

RESULTS

Figure 1 summarises the PRISMA flowchart of study selection, including reasons for exclusion. Forty-two studies (2, 26-66) met the inclusion criteria. Most studies were conducted in the USA, Australia, Canada and Europe, with three from Asia and one from Russia (see Tables 1-4).

Figure 1: PRISMA diagram of study selection

The study setting, design, population, educational interventions, and their respective findings are further described in Tables 1-4. Twenty-two studies were based in general (medical and surgical) wards, nine in intensive care units, four in palliative care units, six in geriatric units and one in the Emergency Department.

[Insert Tables 1-4 here]

Study designs included before-and-after interventions (26 studies), controlled trials (7 studies), comparison (4 studies), cohort (3 studies), and mixed-methods (2 studies). Eight studies employed e-

learning, including computer-based training programs, websites, and online courses to facilitate discussion. 34 studies were of face-to-face education and eight studies were interprofessional. Twenty-six studies involved multi-component educational interventions (27, 29, 31, 32, 39, 40, 42-44, 46-53, 55, 56, 59-62, 64-66). Three studies repeated the educational intervention over time (47, 50, 51).

IMPACT

Overall 37/42 (88%) studies reported improved outcomes post-intervention. Eight studies attempted to improve organizational and patient outcomes (2, 37, 40, 59, 60, 62, 65, 66). Nineteen studies assessed for behavioural change post intervention (2, 26, 34, 36, 39, 41, 44, 47, 50, 52-54, 57, 60-65). Twenty studies measured knowledge gain (28, 31, 32, 34, 35, 38, 39, 42-44, 48, 49, 52, 55, 56, 58, 61-64). Fifteen studies evaluated participants' experiences (27, 29-31, 33, 35, 43, 45, 46, 48, 49, 51, 52, 60, 61).

Reported positive outcomes for inpatient healthcare professionals included an increase in knowledge post-intervention and an increase in confidence in assessing and managing patients with delirium. This translated into a change in practice in diverse ways ranging from an increase in the frequency of delirium monitoring, the appropriate use of assessment tools, and the recognition and documentation of delirium.

Positive outcomes for the patient varied according to the study performed, including an improvement in mortality due to delirium (37), decrease in medication use for delirium (2, 40), decreased duration of delirium and shorter length of stay (2), and overall reduction in the incidence of delirium (66).

QUALITY

Table 5 presents a summary of Kmet scoring for each study, stratified by Kirkpatrick (KP) categories.

The four studies that failed to show a significant difference in outcome (38, 41, 62, 65) are asterixed(*) in the table below.

Table 5 Methodological Quality of Studies as defined by Kmet, categorised by Kirkpatrick

Study	Kmet Quality Items															Total Score
	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
KP 4 - Outcomes measured in terms of organizational change																mean score 78%
Lundstrom et al 2007	2	2	2	2	2	0	1	2	2	2	2	1	2	2	86%	
Vidan et al 2009	2	2	2	2	n	n	n	1	2	2	2	0	2	2	86%	
Wand et al 2014	2	2	2	2	n	n	n	2	1	2	2	0	2	2	86%	
Detroyer et al 2018*	2	2	2	2	n	n	n	2	2	2	2	1	2	0	86%	
Hasemann et al 2016	2	2	2	2	n	n	n	2	2	2	0	0	2	1	77%	
Wald et al 2011	2	2	2	2	n	n	n	1	0	1	2	0	2	1	68%	
Eeles et al 2013	2	2	0	1	n	n	n	2	2	1	1	0	2	1	64%	
Mudge et al 2011*	1	2	0	2	n	n	n	1	1	2	1	0	2	1	59%	
KP3 – Outcomes measured in terms of behavioural change																mean score 71%
Detroyer et al 2016	2	2	2	2	1	n	n	2	2	2	2	2	2	2	96%	
Radtke et al 2012	2	2	2	2	n	n	n	2	1	2	2	2	2	2	95%	
Swan et al 2014	2	2	2	2	n	n	n	2	2	2	2	0	2	2	91%	
Desy et al 2008	2	2	2	2	n	n	n	1	2	2	1	1	2	2	86%	
Kang et al 2016	2	2	2	2	n	n	n	2	2	2	1	1	1	2	86%	
Hickin et al 2017	1	2	2	2	n	n	n	2	2	2	1	0	2	2	82%	
Sockalingam et al 2016	2	2	1	2	n	n	n	1	2	2	1	1	2	2	82%	
Solberg et al 2013	2	2	2	2	n	n	n	2	2	2	1	0	1	2	82%	
Devlin et al 2007	2	2	1	2	n	n	n	1	1	1	2	1	2	2	77%	
Ryan et al 2009	1	2	2	1	n	n	n	1	2	2	2	0	1	2	73%	
Mistraletti et al 2017	2	2	1	0	1	0	0	2	2	2	2	1	2	2	68%	
Pizzacalla et al 2015	1	1	1	0	n	n	n	2	2	1	1	1	2	1	59%	
Law et al 2009*	2	2	1	2	1	2	0	2	1	1	0	1	1	0	57%	
Tkacheva et al 2017	2	0	1	1	n	n	n	0	0	0	0	0	1	1	27%	
Afriyie-Boateng et al 2015	1	1	0	0	n	n	n	1	0	0	0	0	0	1	18%	
KP2 – Outcomes measured in terms of knowledge gain																mean score 59%
Gesin et al 2012	2	2	2	2	n	n	n	1	2	2	1	1	1	2	82%	
Rosenbloom et al 2014	2	2	1	2	n	n	n	2	1	2	2	2	2	2	91%	
McCrow et al 2014	2	2	2	2	2	0	0	2	2	2	2	2	2	2	86%	
van der Steeg et al 2015	2	1	2	2	n	n	n	2	2	2	2	0	2	2	86%	
Wilkerson et al 2014	2	2	2	1	n	n	n	2	2	2	0	0	2	2	77%	
Ramaswamy et al 2011	2	2	1	0	n	n	n	2	1	2	2	0	2	2	73%	
Beach et al 2013	2	2	0	1	n	n	n	1	1	2	2	0	2	1	64%	
Toye et al 2017	1	2	2	2	n	n	n	1	1	1	0	0	2	1	59%	

Teodorczuk et al 2014	1	1	0	0	n	n	n	1	1	2	2	0	2	2	55%
Fadul et al 2007*	1	1	1	0	n	n	n	2	1	2	0	0	2	0	45%
Brajtman et al 2008	2	2	1	0	n	n	n	1	0	1	0	0	0	2	41%
Ashwini et al 2015	0	1	1	1	n	n	n	0	1	1	0	0	0	2	32%
Malik et al 2016	1	0	1	0	n	n	n	1	0	0	0	0	0	0	14%
KP1 – Outcomes measured in terms of learners' experiences															mean score 57%
Akechi et al 2010	2	2	2	2	n	n	n	1	1	2	2	0	2	2	82%
Barbas et al 2014	1	1	1	2	n	n	n	1	1	1	0	1	2	2	59%
Singh et al 2015	2	2	2	1	n	n	n	1	1	1	1	0	1	1	59%
Balas et al 2013	2	1	2	2	n	n	n	0	2	0	0	0	0	2	50%
Page et al 2010	1	2	0	1	n	n	n	0	1	0	0	0	1	2	36%
Corcoran et al 2013	1	1	0	0	n	n	n	1	0	2	0	0	1	0	27%

KP = Kirkpatrick category

(2 = Yes, 1 = Partial, 0 = No, n = not applicable)

n= 42. Studies with a Kmet quality rating of >80% are highlighted in **bold**. Negative studies are marked with *.

Overall, the studies were of variable methodological quality, ranging from 14% to 96% in terms of overall score on the Kmet quality assessment criteria. There were 17 high quality studies (Kmet > 80%) and four very high-quality studies (Kmet over >90%).

SUSTAINABILITY

Thirteen studies (29, 34, 35, 43, 44, 47, 52, 53, 56, 62-64, 66) measured the sustainability of the educational intervention effect, with the follow-up period of these studies ranging from five weeks to 18 months, with a median of five months. Within these studies, two used e-learning methods only (35, 62), three used a combination of face-to-face education and e-learning methods (29, 44, 52) and eight used face-to-face educational methods (34, 43, 47, 53, 56, 63, 64, 66). Four studies (29, 43, 62, 63) found that the effects of their intervention had diminished at follow-up. Across the remainder of the studies the most common finding was that knowledge levels had increased post-intervention (34, 35, 43, 44, 52, 56, 63), followed by an increase in the rate of delirium monitoring (35, 44, 47, 52, 53, 64) and the use of assessment tools (34, 52, 53). One study demonstrated a reduction in the rate of delirium, length-of-stay and use of restraints coupled with a higher rate of mobility (66). A further study demonstrated that a consecutive repetitive cycle of delirium education resulted in a sustained effect at 12 months compared to a standard single educational program (47).

DISCUSSION

This is the first systematic review of delirium education interventions that used PRISMA guidelines to determine impact as defined by Kirkpatrick criteria, coupled with a rigorous assessment of methodological quality (as evaluated by Kmet criteria) and sustainability. Forty-two studies were identified that investigated whether educational interventions improved delirium knowledge, care and/or outcomes. Overall, 88% of studies reported some beneficial impact of the intervention. Eight studies had impact on health outcomes at Kirkpatrick level 4 and the quality of these studies varied from 59%-95%. Quality was high in a large proportion of the studies (40% of studies having Kmet > 80%). Taken together these findings would support the hypothesis that education can improve staff learning and patient healthcare outcomes in research settings.

As expected there existed heterogeneity in the methodological quality of studies, with a Kmet range from 14-96%. However, in general study quality was good with four very high-quality studies. This is a new finding and addition to the literature as previous reviews have focussed on impact only. It was also reassuring to determine that studies were of high quality since there is much interest in education as a non-pharmacological strategy to prevent delirium (19). Without an assessment of the quality of the studies upon which to base these practice changes, it is difficult to make firm recommendations. This is especially the case as education, being a social intervention, can be more challenging to study in a robust manner (67).

Less than a third of the studies looked at sustainability of effect, an important criterion for evaluating cost effectiveness in healthcare interventions. Although a study may have reported significant impact and been of high quality, the sustainability of effect should be considered. Arguably, learning only occurs when knowledge or the acquisition of skills is sustained. Those studies which repeated the educational interventions on more than one occasion had more sustained effects, a finding previously observed and linked to repeated exposure (68).

Moreover, it is important to distinguish between “sustainability of effect” and the term “sustainability,” as defined by implementation science(69). In this review we measured whether an effect of an educational intervention was sustained over time. This is different to sustainability, which is a broader term encompassing the extent to which a new intervention is maintained or becomes part of ongoing operations within an organisation (i.e. integration of an intervention within organisational culture through continued funding, and incorporation within the organisation’s policies and practice) (69).

Face-to-face teaching targeted at nurses was more frequently used compared to novel methods such as e-learning, and the achieved outcomes were generally of a higher level, suggesting a positive behavioural change (e.g. higher rate of neurocognitive assessment completion, and notification of abnormal cognitive state) and patient outcomes (e.g. a reduction in overall mortality rate). This is consistent with Wand’s (19) finding that the efficacy of resource nurses in delirium care appeared to be derived from their reinforcement of teaching in practice, monitoring protocol adherence, and provision of feedback; all of which are reliant upon personal (face-to-face) interactions in the workplace. Previous reviews on the effect of audit and feedback on healthcare outcomes (70, 71) concur with this.

Surprisingly, only 8 of 42 studies evaluated interprofessional education (learning with, from and about each other with the aim to improve collaborative care). This is despite strong theoretical and evidence based recommendations to adopt this education approach to develop collaborative skills (20) and thereby manage the complexity that delirium presents. The complexity of delirium care has previously been articulated in an in-depth Grounded Theory study that identified practice gaps concern developing positive attitudes towards the patient, understanding the distressing nature of delirium, working in partnership with carers and healthcare professionals, recognising delirium and communicating with the patient (15). These practice gaps are in addition to discipline specific more technical delirium learning needs such as prescribing in patients with delirium for doctors.

Implication for practice and recommendations for future educational interventions

The review findings support the hypothesis that education does indeed improve delirium practice since 24 of the studies demonstrated Kirkpatrick change at level 3 or above. Healthcare professionals in hospitals should therefore be exposed to education as an evidence based non-pharmacological approach to ultimately benefit patients and carers, but impact will vary across differing educational interventions. These findings provide empirical support to the well-rehearsed theoretical arguments as to why delirium education is necessary, though not sufficient to improve delirium care (8). Moreover, the four highest rated studies covered four different educational approaches; e-learning, cyclical staff training, family inclusive education and nurse educator led training (34, 47, 49, 54). Hence, support exists for a variety of approaches to education across the continuum, although we are unable to determine effect sizes and directly compare efficacy.

However, in terms of implications for practice, there are three important caveats to these conclusions. Firstly, due to the limited descriptions of the intervention and the absence of any discussion of the underpinning educational theory, it becomes challenging to replicate the educational approaches and transfer them to other practice settings. Nonetheless, as education is a social process and context bound, the lack of description of what is in the 'black box' may be less of a limitation. There is recognition within the field of medical education research that too many studies set out to determine whether or not a teaching intervention works; as invariably when learners are taught, they learn (67). Future research on delirium teaching interventions ought therefore to place greater focus on conducting so called 'clarification studies', that seek to understand how and why a teaching intervention works thus allowing these principles to be transposed to other settings (72). Hence, we call for a further realist review to complement this review and determine what works in which settings and for whom.

Secondly, studies were characterised by a predominant focus on knowledge and skills, as opposed to attitudinal learning outcomes. Similar findings have been seen in reviews of medical undergraduate

curriculum (73). This is an important critique, since negative attitudes towards patients with delirium are well recognised and undermine care in clinical settings (74). This lack of attitudinal learning content may reflect the challenges inherent to assessing whether a learner has achieved a learning outcome centred on attitudinal change. Future studies could explore whether interventions focussed on attitude change hold greater efficacy.

Thirdly, it is well recognised that transfer of learning is nonlinear (75). Importantly, it is limited by situational interprofessional pressures (76) and cultural barriers (77) that may ultimately block the effectiveness of the educational intervention in real life settings. Arguably, most learning occurs amongst clinical staff from non-formal processes outside of classroom or eLearning settings (75). A focus on learning through practice was absent from the studies reviewed and further work is needed to explore whether informal learning processes and artefacts can be used to support the formal learning.

Limitations and strengths

The key strength of this review was that both study impact and quality were evaluated. Additionally, a wide range of settings were included, widening the relevance of the results to a variety of clinicians. A broad search strategy enabled identification of studies across the education continuum including eLearning, IPE and education involving families.

There were several limitations including the exclusion of the grey literature or unpublished studies, in which negative studies are likely to be better represented and which may have offset potential publication bias. Moreover, only literature published in English was included, perhaps leading to the Western preponderance, which may limit generalisability. The decision to only review papers published in the last decade may have resulted in a selection bias. However, we sought to focus upon recent innovation and technology less well explored in previous reviews (18-20). Other possible biases included our assumption that what was reported in the paper represented the fullness of the approach. Lastly, as has been noted in previous reviews (18, 19, 78), many delirium interventions evaluated in

this review were multicomponent in nature, with education only one aspect. Therefore, it remains difficult to determine which elements truly underpinned effectiveness.

Conclusions

Delirium is an under recognised, common, highly distressing and costly illness. Education therefore holds much promise in addressing the fact that it remains invisible in hospital settings (77). This review provides robust evidence that educational approaches from across the continuum can improve outcomes at learner and patient levels. Despite identifying considerable variability in the quality of the studies reviewed, there were sufficient high-level studies to justify ongoing investment and support for education. Further research is needed to explore aspects such as the attitudes of health professionals and learning through practice. Sustainability and implementation science studies may open further fruitful avenues of research. Moreover, there is a need to further research education in other settings such as the community and education targeted at non-clinician stakeholders such as patients, family and carers. Though the current practice and experience of delirium in hospitals remains challenging and suboptimal, our study offers hope and points to potential educational approaches that hold promise for the future.

Conflicts of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

<4294 words

REFERENCES

1. Siddiqi N, House AO, Holmes JD. Occurrence and outcome of delirium in medical in-patients: a systematic literature review. *Age and Ageing*. 2006;35(4):350-64.
2. Lundström M, Olofsson B, Stenvall M, Karlsson S, Nyberg L, Englund U, et al. Postoperative delirium in old patients with femoral neck fracture: a randomized intervention study. *Aging Clinical & Experimental Research*. 2007;19(3):178-86.
3. Adamis D, Treloar A, Martin FC, Macdonald AJD. Recovery and outcome of delirium in elderly medical inpatients. *Archives of Gerontology and Geriatrics*. 2006;43(2):289-98.
4. Kat MG, Vreeswijk R, de Jonghe JFM, van der Ploeg T, van Gool WA, Eikelenboom P, et al. Long-Term Cognitive Outcome of Delirium in Elderly Hip Surgery Patients. *Dementia and Geriatric Cognitive Disorders*. 2008;26(1):1-8.
5. Davis DH, Muniz Terrera G, Keage H, Rahkonen T, Oinas M, Matthews FE, et al. Delirium is a strong risk factor for dementia in the oldest-old: a population-based cohort study. *Brain*. 2012;135(9):2809-16.
6. Collins N, Blanchard M, A T, Sampson E. Detection of delirium in the acute hospital. *Age and Ageing*. 2010;39(1):131-5.
7. Kales HC, Kamholz BA, Visnic SG, Blow FC. Recorded delirium in a national sample of elderly inpatients: potential implications for recognition. *J Geriatr Psychiatry Neurol*. 2003;16(1):32-8.
8. Teodorczuk A, Reynish E, Milisen K. Improving recognition of delirium in clinical practice: a call for action. *BMC Geriatr*. 2012;12:55.
9. MacLulich AM, Hall RJ. Who understands delirium? *Age Ageing*. 2011;40(4):412-4.
10. Hsieh TT, Yue J, Oh E, Puelle M, Dowal S, Trivison T, et al. Effectiveness of multicomponent nonpharmacological delirium interventions: a meta-analysis. *JAMA internal medicine*. 2015;175(4):512-20.
11. Abraha I, Trotta F, Rimland JM, Cruz-Jentoft A, Lozano-Montoya I, Soiza RL, et al. Efficacy of Non-Pharmacological Interventions to Prevent and Treat Delirium in Older Patients: A Systematic Overview. The SENATOR project ONTOP Series. *PloS one*. 2015;10(6):e0123090.
12. Tabet N, Howard R. Non-pharmacological interventions in the prevention of delirium. *Age Ageing*. 2009;38(4):374-9.
13. Rockwood K. Educational interventions in delirium. *Dement Geriatr Cogn Disord*. 1999;10(5):426-9.
14. Pierre JS. Delirium: a process improvement approach to changing prescribing practices in a community teaching hospital. *J Nurs Care Qual*. 2005;20(3):244-50; quiz 51-2.
15. Teodorczuk A, Corbett S, Welfare M, Mukaetova Ladinska E. Reconceptualising models of delirium education: Findings of a Grounded Theory study. *International Psychogeriatrics*. 2013;25(4):645 - 55.
16. Coyle MA, Burns P, Traynor V. Is it my job? The role of RNs in the assessment and identification of delirium in hospitalized older adults: an exploratory qualitative study. *Journal of gerontological nursing*. 2017;43(4):29-37.
17. Yanamadala M, Wieland D, Heflin MT. Educational interventions to improve recognition of delirium: a systematic review. *Journal of the American Geriatrics Society*. 2013;61(11):1983-93.
18. Teodorczuk A, Welfare M, Corbett S, Mukaetova-Ladinska E. Developing effective educational approaches for Liaison Old Age Psychiatry teams: a literature review of the learning needs of hospital staff in relation to managing the confused older patient. *International psychogeriatrics / IPA*. 2010;22(6):874-85.
19. Wand AP. Evaluating the effectiveness of educational interventions to prevent delirium. *Australas J Ageing*. 2011;30(4):175-85.
20. Sockalingam S, Tan A, Hawa R, Pollex H, Abbey S, Hodges BD. Interprofessional education for delirium care: a systematic review. *Journal of interprofessional care*. 2014;28(4):345-51.

21. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *International Journal of Surgery*. 2010;8(5):336-41.
22. Covidence.org. Covidence 2017 [Available from: <https://www.covidence.org/>].
23. Kmet LM, Lee RC, Cook LS. Standard quality assessment criteria for evaluating primary research papers from a variety of fields: Alberta Heritage Foundation for Medical Research Edmonton; 2004.
24. Jackson M, Pelone F, Reeves S, Hassenkamp AM, Emery C, Titmarsh K, et al. Interprofessional education in the care of people diagnosed with dementia and their carers: a systematic review. *BMJ open*. 2016;6(8):e010948.
25. Kirkpatrick D. Evaluating training programs: the four levels. San Francisco: Berrett-Koehler; 1994.
26. Afriyie-Boateng M, Loftus C, Hamelin MA. Use of a multimodal implementation strategy to improve delirium screening by nurses on an acute care for elders unit. *Worldviews on Evidence Based Nursing*. 2015;12(6):389-91.
27. Akechi T, Ishiguro C, Okuyama T, Endo C, Sagawa R, Uchida M, et al. Delirium training program for nurses. *Psychosomatics*. 2010;51(2):106-11.
28. Ashwini, Prabhu S, Shetty S, Prabhu V, Pais M, Kuriakose B. Effectiveness of structured teaching programme on prevention of ICU delirium among nurses. *Nitte University Journal of Health Science*. 2015;5(2):28-30.
29. Balas MC, Burke WJ, Gannon D, Cohen MZ, Colburn L, Bevil C, et al. Implementing the awakening and breathing coordination, delirium monitoring/management, and early exercise/mobility bundle into everyday care: opportunities, challenges, and lessons learned for implementing the ICU Pain, Agitation, and Delirium Guidelines. *Critical Care Medicine*. 2013;41(9 Suppl 1):S116-27.
30. Barbas AS, Haney JC, Henry BV, Heflin MT, Lagoo SA. Development and Implementation of a Formalized Geriatric Surgery Curriculum for General Surgery Residents. *Gerontology & Geriatrics Education*. 2014;35(4):380-94.
31. Beach SR, Chen DT, Huffman JC. Educational impact of a psychiatric liaison in the medical intensive care unit: Effects on attitudes and beliefs of trainees and nurses regarding delirium. *Primary Care Companion to the Journal of Clinical Psychiatry*. 2013;15(3).
32. Brajtman S, Hall P, Weaver L, Higuchi K, Allard P, Mullins D. An interprofessional educational intervention on delirium for health care teams: Providing opportunities to enhance collaboration. *Journal of interprofessional care*. 2008;22(6):658-60.
33. Corcoran AM, Lysaght S, LaMarra D, Ersek M. Pilot test of a three-station palliative care observed structured clinical examination for multidisciplinary trainees. *Journal of Nursing Education*. 2013;52(5):294-8.
34. Desy PM, Prohaska TR. The Geriatric Emergency Nursing Education (GENE) Course: An Evaluation. *Journal of Emergency Nursing*. 2008;34(5):396-402.
35. Detroyer E, Dobbels F, Debonnaire D, Irving K, Teodorczuk A, Fick DM, et al. The effect of an interactive delirium e-learning tool on healthcare workers' delirium recognition, knowledge and strain in caring for delirious patients: a pilot pre-test/post-test study. *BMC medical education*. 2016;16:17.
36. Devlin JW, Fong JJ, Schumaker G, O'Connor H, Ruthazer R, Garpestad E. Use of a validated delirium assessment tool improves the ability of physicians to identify delirium in medical intensive care unit patients. *Critical Care Medicine*. 2007;35(12):2721-4.
37. Eeles E, Thompson L, McCrow J, Pandey S. Management of delirium in medicine: Experience of a Close Observation Unit. *Australasian Journal on Ageing*. 2013;32(1):60-3.
38. Fadul N, Kaur G, Zhang T, Palmer JL, Bruera E. Evaluation of the memorial delirium assessment scale (MDAS) for the screening of delirium by means of simulated cases by palliative care health professionals. *Supportive Care in Cancer*. 2007;15(11):1271-6.

39. Gesin G, Russell BB, Lin AP, Norton HJ, Evans SL, Devlin JW. IMPACT OF A DELIRIUM SCREENING TOOL AND MULTIFACETED EDUCATION ON NURSES' KNOWLEDGE OF DELIRIUM AND ABILITY TO EVALUATE IT CORRECTLY. *American Journal of Critical Care*. 2012;21(1):e1-e11.
40. Hasemann W, Tolson D, Godwin J, Spirig R, Frei IA, Kressig RW. A before and after study of a nurse led comprehensive delirium management programme (DemDel) for older acute care inpatients with cognitive impairment. *International Journal of Nursing Studies*. 2016;53:27-38.
41. Law E, Connelly P, Prentice N, Rooke D. Educating staff about delirium in an acute hospital setting. *Progress in Neurology and Psychiatry*. 2009;13(6):37-9.
42. Malik A, Harlan T, Cobb J. Stop. Think. Delirium! A quality improvement initiative to explore utilising a validated cognitive assessment tool in the acute inpatient medical setting to detect delirium and prompt early intervention. *Journal of Clinical Nursing*. 2016;25(21/22):3400-8.
43. McCrow J, Sullivan KA, Beattie ER. Delirium knowledge and recognition: a randomized controlled trial of a web-based educational intervention for acute care nurses. *Nurse education today*. 2014;34(6):912-7.
44. Mistraletti G, Umbrello M, Anania S, Andrichi E, Di Carlo A, Marti Netti F, et al. Neurological assessment with validated tools in general ICU: Multicenter, randomized, before and after, pragmatic study to evaluate the effectiveness of an e-learning platform for continuous medical education. *Minerva Anestesiologica*. 2017;83(2):145-54.
45. Page JB, Kowlowitz V, Alden KR. Development of a scripted unfolding case study focusing on delirium in older adults. *Journal of Continuing Education in Nursing*. 2010;41(5):225-30.
46. Pizzacalla A, Montemuro M, Coker E, Martin LS, Gillies L, Robinson K, et al. Gentle persuasive approaches: introducing an educational program on an orthopaedic unit for staff caring for patients with dementia and delirium. *Orthopedic nursing*. 2015;34(2):101-7; quiz 8.
47. Radtke FM, Heymann A, Franck M, Maechler F, Drews T, Luetz A, et al. How to implement monitoring tools for sedation, pain and delirium in the intensive care unit: An experimental cohort study. *Intensive Care Medicine*. 2012;38(12):1974-81.
48. Ramaswamy R, Dix EF, Drew JE, Diamond JJ, Inouye SK, Roehl BJ. Beyond grand rounds: a comprehensive and sequential intervention to improve identification of delirium. *The Gerontologist*. 2011;51(1):122-31.
49. Rosenbloom DA, Fick DM. Nurse/family caregiver intervention for delirium increases delirium knowledge and improves attitudes toward partnership. *Geriatric Nursing*. 2014;35(3):175-81.
50. Ryan K, Leonard M, Guerin S, Donnelly S, Conroy M, Meagher D. Validation of the confusion assessment method in the palliative care setting. *Palliative Medicine*. 2009;23(1):40-5.
51. Singh I, Morgan K, Belludi G, Verma A, Aithal S. Does nurses' education reduce their work-related stress in the care of older people? *Journal of Clinical Gerontology and Geriatrics*. 2015;6(1):34-7.
52. Sockalingam S, James SL, Sinyi R, Carroll A, Laidlaw J, Yanofsky R, et al. A Flipped Classroom Approach to Improving the Quality of Delirium Care Using an Interprofessional Train-the-Trainer Program. *The Journal of continuing education in the health professions*. 2016;36(1):17-23.
53. Solberg LM, Plummer CE, May KN, Mion LC. NGNA Section. A quality improvement program to increase nurses' detection of delirium on an acute medical unit. *Geriatric Nursing*. 2013;34(1):75-9.
54. Swan JT. DECREASING INAPPROPRIATE UNABLE-TO-ASSESS RATINGS FOR THE CONFUSION ASSESSMENT METHOD FOR THE INTENSIVE CARE UNIT. *American Journal of Critical Care*. 2014;23(1):60-9.
55. Teodorczuk A, Mukaetova-Ladinska E, Corbett S, Welfare M. Learning about the patient: an innovative interprofessional dementia and delirium education programme. *The clinical teacher*. 2014;11(7):497-502.

56. Toye C, Kitchen S, Hill A, Edwards D, Sin M, Maher S. Piloting staff education in Australia to reduce falls in older hospital patients experiencing delirium. *Nursing & Health Sciences*. 2017;19(1):51-8.
57. Tkacheva ON, Runikhina NK, Vertkin AL, Voronina IV, Sharashkina NV, Mkhitaryan EA, et al. The diagnosis of delirium in an acute-care hospital in Moscow: What does the Pandora's box contain? *Clinical Interventions in Aging*. 2017;12:343-9.
58. van de Steeg L, R IJ, Wagner C, Langelaan M. The effect of an e-learning course on nursing staff's knowledge of delirium: a before-and-after study. *BMC medical education*. 2015;15:12.
59. Wald HL, Glasheen JJ, Guerrasio J, Youngwerth JM, Cumbler EU. Evaluation of a hospitalist-run acute care for the elderly service. *Journal of Hospital Medicine*. 2011;6(6):313-21.
60. Wand APF, Thoo W, Sciuriaga H, Ting V, Baker J, Hunt GE. A multifaceted educational intervention to prevent delirium in older inpatients: A before and after study. *International Journal of Nursing Studies*. 2014;51(7):974-82.
61. Wilkerson LM, Iwata I, Wilkerson MD, Heflin MT. An Educational Intervention to Improve Internal Medicine Interns' Awareness of Hazards of Hospitalization in Acutely Ill Older Adults. *Journal of the American Geriatrics Society*. 2014;62(4):727-33.
62. Detroyer E, Dobbels F, Teodorczuk A, Deschodt M, Depaifve Y, Joosten E, et al. Effect of an interactive E-learning tool for delirium on patient and nursing outcomes in a geriatric hospital setting: findings of a before-after study. *BMC geriatrics*. 2018;18(1):19.
63. Hickin SL, White S, Knopp-Sihota J. Nurses' knowledge and perception of delirium screening and assessment in the intensive care unit: Long-term effectiveness of an education-based knowledge translation intervention. *Intensive and Critical Care Nursing*. 2017;41:43-9.
64. Kang Y, Moyle W, Cooke M, O'dwyer ST. An educational programme to improve acute care nurses' knowledge, attitudes and family caregiver involvement in care of people with cognitive impairment. *Scandinavian journal of caring sciences*. 2017;31(3):631-40.
65. Mudge A, Maussen C, Duncan J, Denaro C. Improving quality of delirium care in a general medical service with established interdisciplinary care: a controlled trial. *Internal medicine journal*. 2013;43(3):270-7.
66. Vidán MT, Sánchez E, Alonso M, Montero B, Ortiz J, Serra JA. An intervention integrated into daily clinical practice reduces the incidence of delirium during hospitalization in elderly patients. *Journal of the American Geriatrics Society*. 2009;57(11):2029-36.
67. Eva KW. Broadening the debate about quality in medical education research. *Medical education*. 2009;43(4):294-6.
68. Cervero RM, Gaines JK. The impact of CME on physician performance and patient health outcomes: an updated synthesis of systematic reviews. *Journal of Continuing Education in the Health Professions*. 2015;35(2):131-8.
69. Proctor E, Silmere H, Raghavan R, Hovmand P, Aarons G, Bunger A, et al. Outcomes for implementation research: conceptual distinctions, measurement challenges, and research agenda. *Administration and Policy in Mental Health and Mental Health Services Research*. 2011;38(2):65-76.
70. Jamtvedt G, Young JM, Kristoffersen DT, O'Brien MA, Oxman AD. Audit and feedback: effects on professional practice and health care outcomes. *Cochrane Database Syst Rev*. 2006;2(2).
71. Cervero RM, Gaines JK. The impact of CME on physician performance and patient health outcomes: an updated synthesis of systematic reviews. *The Journal of continuing education in the health professions*. 2015;35(2):131-8.
72. Cook DA, Bordage G, Schmidt HG. Description, justification and clarification: a framework for classifying the purposes of research in medical education. *Medical Education*. 2008;42(2):128-33.
73. Fisher JM, Gordon AL, MacLulich AMJ, Tullo E, Davis DHJ, Blundell A, et al. Towards an understanding of why undergraduate teaching about delirium does not guarantee gold-standard practice—results from a UK national survey. *Age and Ageing*. 2015;44(1):166-70.

74. Teodorczuk A, Mukaetova-Ladinska E, Corbett S, Welfare M. Reconceptualizing models of delirium education: findings of a Grounded Theory study. *International Psychogeriatrics*. 2013;25(04):645-55.
75. Teodorczuk A, Billett S. Mediating workplace situational pressures: The role of artefacts in promoting effective interprofessional work and learning. *Focus on Health Professional Education: A Multi-disciplinary Journal*. 2017;18(3):80.
76. Gherardi S. Practice-based theorizing on learning and knowing in organizations: An introduction. *Organization*. 2000;7(2):211-23.
77. Teodorczuk A, MacLulich A. New waves of delirium understanding. *International journal of geriatric psychiatry*. 2018;33(11):1417-9.
78. Clegg A, Siddiqi N, Heaven A, Young J, Holt R. Interventions for preventing delirium in older people in institutional long-term care. *Cochrane Database Syst Rev*. 2014;1.

Table 1 Overview of Kirkpatrick Level 1 studies (Negative studies are marked with *)

Reference	Country	Study Design	Study targets	Study population (including age)	Educational interventions	Findings	Sustainability	Setting
Akechi 2010	Japan	Comparison between nurses in participating wards (receiving intervention) and nurses in non-participating wards	423 Nurses	All inpatients except mixed department ward (Radiology, Heart Surgery, Endocrinology), Neonatal Intensive Care Unit/Pediatric Surgery and Obstetrics Department	Face-to-face education 1) Two delirium workshops including 1 lecture on delirium, and the introduction of the NEECHAM confusion scale, case presentations and small group discussions 2) Eight 1-hour question and answer sessions between participants and educators	1) Significant increase in total self-confidence scores reported by participants in the areas of delirium identification, differentiation, explanation, provision of care, appropriate monitoring and setting of care goals for patients with delirium with an increase to 57.1 points post-intervention from 42.1 pre-intervention (out of a 150-point total)	Not described	General
Balas 2013	USA	Prospective, mixed-method, implementation of delirium management standard, with measurement taken at baseline, 4 months and 9 months	220 registered nurses, 70 respiratory therapists, 5 pharmacists, 4 nurse practitioners, 1 physiotherapist assistant, 17 intensivists, 9 fellows	All ICU inpatients with length of stay greater than 24 hours	Face-to-face education and e-learning 1) 30-minute computer-based training program 2) Medical grand rounds presentation by ICU delirium expert 3) Development and presentation of nurse-led 8-hour education day 4) Outcomes measured at 4 months and 9 months	1) Participants felt that the educational material positively influenced their patient outcomes (77%), was applicable to their current practice (68%) and was evidence-based (68%). 2) Decrease in percentage of staff agreeing with the statements that "delirium is a problem often encountered" (85.7% to 62.1% to 77.3%), and "delirium negatively affects patient outcomes" (92.8% to 86.1% to 81.8%). 3) Decrease in the percentage of staff agreeing to the statement that "it is easy to ask questions" (100% to 86.1% to 80.9%), that "physicians and nurses work together well" (100% to 58.8% to 78.6%), that "interdisciplinary rounds are regularly performed" (78.6% to 59.3% to 82.1%), and that "their input is well received in the interdisciplinary rounds" (100% to 66.7% to 84.4%).	9 months	ICU

Barbas 2014	USA	Before and after intervention	50 General surgical residents	Not described	Face-to-face education 1) Lecture series of sixteen 1-hour didactic sessions (1 lecture on delirium) 2) Increased satisfaction of general surgical residents with geriatric education from 8.7% preintervention to 40.4% postintervention.	1) The percentage of residents felt that managing delirium was important improved from 70.5% pre-intervention to 85.1% post intervention. 2) Increased satisfaction of general surgical residents with geriatric education from 8.7% preintervention to 40.4% postintervention.	Not described	General
Corcoran 2013	USA	Pilot study, mixed methods, implementation of OSCE	7 Advanced Practice Nurses in Palliative care, 3 geriatric fellows, 2 oncology and palliative medicine	Not described	Face-to-face education 1) 3-hour Observed Structured Clinical Examination (OSCE) session, including a lecture session, 3 stations, and a discussion session after each station	1) Mean scores on the Interpersonal Skills Tool rating learners' performance was significantly higher when rated by the standardized patients and faculty raters (23 and 25 out of 28 respectively) compared to self-rating (21 out of 28)	Not described	Palliative Care
Page 2010	USA	Before and after intervention	230 registered nurses, 112 licensed practical nurses, 152 nursing assistants	Not described	Face-to-face education 1) Small group of 5-6 individuals with a facilitator, with the venue resembling the setting of the case (patient in a hospital bed with delirium), facilitator providing a brief description of each character in the case study, participants volunteering and provided with props appropriate for each character, and a debriefing session at the conclusion of the case	1) 95.7% of participants provided feedback that their ability to identify strategies to improve the cognition of acutely confused elderly patients were improved	Not described	General
Singh 2015	UK	Before and after intervention	Nurses in care of the elderly (CoTE) wards	Not described	Face-to-face education 1) Twice a week 30-minute training session delivered for 6 consecutive weeks, with each 6-week cycle repeated 2 more times 2) Each individual session included lectures, case-based discussions and reflective practice	1) No significant reduction in overall stress measured by Expanded Nursing Stress Score (ENSS) (137.46 ± 41.82 pre-intervention and 122.48 ± 29.14 post-intervention) 2) Stress related to workload was 27.15 ± 5.04 before teaching, and after teaching it was significantly lower (20.86 ± 5.18)	Not described	Geriatric

Table 2 Overview of Kirkpatrick Level 2 studies (Negative studies are marked with *)

Reference	Country	Study Design	Study targets	Study population (including age)	Educational interventions	Findings	Sustainability	Setting
Ashwini 2015	India	Before and after intervention	40 ICU staff nurses	Inpatients ICU	Face-to-face education 1) 8 days of structured teaching on delirium to nurses working in ICU	1) Increase in staff knowledge levels measured in ICU delirium measured by a knowledge questionnaire, with 7.5% of participants achieving good scores pre-test, to 100% of participants achieving good scores post-test.	Not described	ICU
Beach 2013	USA	Comparison between internal medicine residents, critical care nurses and psychiatry residents	Critical care nurses, internal medicine residents	ICU inpatients	Face-to-face education 1) Weekly psychiatry resident presence at ward rounds 2) 3-5-minute discussions involving psychiatric topics, including delirium	1) Significant decline in the percentage of critical care nurses agreeing with the statement "Delirium is diagnosed less often than it occurs" (100% pre-intervention vs 80% post-intervention) 2) Significant increase critical care nurses agreeing with the statement "Patients with new-onset anxiety or depression in the intensive care unit most commonly have delirium" (17.4% pre-intervention vs 56.0% post intervention) 3) Statistical insignificant difference in both internal medicine resident and psychiatry resident groups, and also when all study target groups were combined	Not described	ICU
Bratjman 2008	Canada	Before and after intervention	2 physicians, 1 medical student, 3 nurses, 1 dietitian, 1 pharmacist, 1 chaplain and 1 volunteer	Not described	Face-to-face education 1) Three patient-based case scenarios with increasing complexity and one role-playing exercise 2) Three interactive 1-hour sessions over a 1-month period consisting of a case study, discussions and a short presentation	1) Improved scores on the Interprofessional Delirium Knowledge Test post-intervention compared to pre-intervention 2) The mean scores for the leadership, cohesion, communication, coordination and conflict domains of the Interprofessional Team Performance Scale were all higher after the intervention	Not described	Palliative care
Fadul 2007*	USA	Before and after intervention	11 physicians, 12 nurses, 8 staff from	Not described	Face-to-face education 1) 2-hour session including a 20-minute formal description of the memorial delirium assessment scale (MDAS), 40-minute	1) Correct diagnosis achieved by study targets in 96% of the assessments after the education; no pre-interventional measurements were done	Not described	Palliative care

			other disciplines		presentation of the manual followed by a discussion, 15-minutes for questions and comments, and 45-minutes for simulated cases.	2) There was no difference in the correct diagnosis in each patient according to the profession of the study target		
Gesin 2012	USA	Multi-stage cohort study comparing performance of staff against validated judge, at baseline prior to educational intervention (Phase 1), against passive education (Phase 2) and multifaceted educational interventions (Phase 3)	20 nurses	ICU patients more than 18 years of age	<p>Face-to-face education</p> <p>1) Provision of ICDSC screening form and written evidence of validity (Phase 2)</p> <p>2) 30-slide live presentation by pharmacist, webcast of the live presentation, and bedside demonstration of ICDSC by validated judge (Phase 3)</p>	<p>1) Significant increase in mean nursing knowledge from 6.1 at Phase 1 to 6.5 at Phase 2, and 8.2 at Phase 3 (out of 10).</p> <p>2) Decrease in proportion of nurses perceiving delirium to be challenging to assess from 89.5% in Phase 1, to 78.9% in Phase 2, to 63.2% in Phase 3.</p> <p>3) Increase in proportion of nurses who agreed that ICDSC helps in identifying delirium in patients from 57.9% in Phase 1, to 78.9% in Phase to, to 89.5% in Phase 3</p>	Not described	ICU
Malik 2016	USA	Quality improvement project, before and after intervention	Nurses	Patients aged 65 years and older	<p>Face-to-face education</p> <p>1) Training sessions offered by experts in delirium comprising risk factors, signs, symptoms, and approaches to eliminate progression of the condition.</p> <p>2) PowerPoint slides and training materials were provided to all staff in the inpatient medical unit, including hard copies of training information in binders, laminated pocket cards.</p> <p>3) Emails were sent to all staff with a video on delirium and facts regarding delirium management</p>	<p>1) Improvement in response rate of knowledge assessment questionnaires, from 60% (pre-intervention) to 85% (post intervention)</p> <p>2) Improvement in average score of knowledge assessment questionnaire from 58% (pre-intervention) to 61% (post intervention), with no mention of statistical significance</p> <p>3) No change to compliance with using validated delirium screening tool, or consistent documentation</p>	Not described	General

McCrow 2014	Australia	Multi-site controlled trial with cluster randomization	147 Registered nurses	Not described	<p>E-learning</p> <p>1) Educational website (learnaboutdelirium.com) including delirium facts, delirium management strategies, information about recognizing delirium using CAM, videos of actors with various clinical presentations, questions and answers, and links to other educational websites.</p> <p>2) Discussion forum incorporated into website.</p>	<p>1) Participants in the intervention group had statistically significant higher increments in delirium knowledge scores over time (19.67 vs. 20.05 at baseline; 25.43 vs 21.86 post intervention; 25.62 vs 23.02 at 5-weeks follow up)</p> <p>2) Within the intervention group, there was a statistically significant increase in mean delirium recognition scores post intervention, but not at 5-weeks post follow up.</p> <p>3) 78% of participants in the intervention group reported that the educational website had improved their delirium knowledge</p> <p>4) 80% of participants in the intervention group found the educational website to be flexible, relevant to clinical practice and interesting</p>	5 weeks	General
Ramaswamy 2010	USA	Before and after intervention	58 nurses, 18 physicians, 19 trainees, 24 staff from other departments	Not described	<p>Face-to-face education</p> <p>1) 2-day visiting professorship by an internationally recognized expert on delirium, targeting direct patient care providers from multiple disciplines throughout the hospital.</p> <p>2) 4 progressive didactic sessions interspersed with key content repeated in subsequent sessions to reinforce select concepts (e.g., use of low-dose haloperidol as first-line drug therapy for delirium in elderly patients)</p> <p>3) Interactive small group sessions and continuing nursing education sessions after each didactic session.</p>	<p>1) Significant improvement in post-intervention knowledge scores in participants attending 2 or more sessions (3.8 points), non-significant improvement in post-intervention knowledge scores in participants attending 1 session (1.3 points) compared to pre-intervention scores.</p> <p>2) Significant increase of proportion of participants reporting confidence in taking the knowledge test from 52% pre-intervention to 80% post-intervention</p> <p>3) Significant increase in self-assessed capacity to administer the CAM from 28% pre-intervention to 64% post-intervention</p>	Not described	General
Rosenbloom 2014	USA	Prospective cohort study comparing	14 Staff nurses	Patients over 60 years of age, admitted into a medical unit, with	<p>Face-to-face education</p> <p>1) 15-minute educational session to staff nurses on day 3-7 of admission (5 days total) delivered to staff nurses via verbal review of</p>	<p>1) Significant improvement in the knowledge of delirium for subjects in the intervention group (from 0.58 to 0.61) compared to the control group (from 0.45 to 0.47)</p>	Not described	General

		effect of intervention		a length of stay of 8-10 days, and with a discharge destination of home	<p>a folder, review of a brochure or viewing of a video, with content including a brief definition of delirium and information on risk factors, symptoms, treatment and preventative interventions</p> <p>2) Training of a unit nurse champion (UNC), which involved the investigator providing 4 one-hour educational sessions regarding the intervention, and whose role was to provide peer support and support to other providers in the interventional unit.</p>	<p>2) Significant improvement in attitudes toward aging measured by Expectations Regarding Aging Scale (ERA-12) in the intervention group (from 41.3 to 50.6) compared to control group (from 34.5 to 33.3)</p> <p>3) Significant increase in case vignette scores on 8 weeks post intervention in intervention group (from 0.19 to 0.32 and from 0.66 to 0.72) compared to control group (from 0.31 to 0.26 and 0.52 to 0.38)</p>		
Teodorczuk 2014	UK	Before and after intervention	15 nurses, 8 healthcare assistants, 2 domestic staff, 2 ward clerks, 5 modern matrons, 8 physiotherapists, 2 occupational therapists, 3 doctors, 2 pharmacists, 1 porter	Not described	<p>Face-to-face education</p> <p>1) 2-day course, with content on day-1 challenging beliefs and attitudes about the confused older patient, and day-2 focusing on managing complex cases and practice change</p> <p>2) Part of the course was taught by patients, and this was further promoted by 2 patient videos</p>	<p>1) Significant improvement in learner confidence in patient management measured by median Likert scores (out of 5) in the domains of:</p> <p>i) Practice with the confused older patient (from 2.0 to 4.0)</p> <p>ii) Understanding of patient-centred care (from 4.0 to 5.0)</p> <p>iii) Ability to manage difficult cases (from 2.0 to 3.0)</p> <p>iv) Understanding roles (from 3.0 to 4.0)</p> <p>v) Working with carers (from 3.0 to 5.0)</p>	Not described	General
Toye 2017	Australia	Before and after intervention	7 junior doctors, 7 allied health practitioners, 45 nursing staff members	Patients aged 65 years or older present on the ward on designated audit days	<p>Face-to-face education</p> <p>1) Joint education session for nursing and allied health staff run by a senior nurse lasting 30 minutes, with emphasis on observing for signs of delirium and implementing prescribed falls risk management strategies</p> <p>2) 30-minute education session for junior doctors assigned to the participating ward,</p>	1) Significant improvement in the median score of the knowledge test from 6.5 (pre-intervention) to 9 (post-intervention) for risk; and from 11 (pre-intervention) to 13 (post-intervention) for presentation/management.	2 months	General

					run by a senior geriatrician, with emphasis on diagnosis and treatment of underlying conditions causing delirium, and reviewing existing treatments with the potential to exacerbate falls risk.			
Van der Steeg 2015	The Netherlands	Multi-centre before and after intervention	907 Nurses	Not described	E-learning E-learning course containing information on the clinical features, risk factors, diagnostics, prevention and treatment of delirium, with an estimated completion time of 4 hours with a baseline and final open book knowledge test included.	1) Knowledge test mean scores significantly increased from 79.3 at baseline to 87.4 post-intervention	Not described	General
Wilkerson 2014	USA	Before and after intervention	42 Internal medicine residents	Not described	Face-to-face education and e-learning 1) Assigned reading material with online modules (1 of the included topics being delirium), which also included the presentation of several validated screening tools including the CAM and GDS 2) Attendance on geriatrics consultation service, including following at least 1 consultation patient and completing a checklist that is reviewed by the geriatrics attending physician or fellow	1) Significant increase of total knowledge scores by 0.78 points (out of a total of 3) post intervention compared to baseline. 2) Significant increase in self-reported confidence in managing “hazards of hospitalization”, with the greatest gain in delirium (2.73 pre-intervention vs 3.98 post intervention on a 5-point Likert scale). 3) Significant increase in confidence in performing the CAM (1.93 pre-intervention vs 4.45 post intervention on a 5-point Likert scale) 4) Although not statistically significant, interns who accepted the educational intervention were more likely to document a prevention strategy and document using a sitter for patients admitted with delirium compared to their colleagues	Not Described	General

Table 3 Overview of Kirkpatrick Level 3 studies (Negative studies are marked with *)

Reference	Country	Study Design	Study targets	Study population (including age)	Educational interventions	Findings	Sustainability	Setting
Afriyie-Boateng 2015	Canada	Before and after intervention	All nurses working in ACE unit	Older adult (age 65 and over) inpatients	E-learning 1) Mandatory completion of e-learning module with interactive cases	1) Increase in CAM completion rates in inpatients from 60% (pre-implementation) to peak of 100% (during implementation) 2) Average CAM completion rate of 80% compared to 64% in a medical unit	Not described	Geriatric
Desy 2008	USA	Before and after intervention	102 Emergency nurses	Not described	Face-to-face education 1) Geriatric Emergency Nursing Education (GENE) course, comprised of 10 modules, with diagnosing delirium included in the curriculum, and incorporating validated age-appropriate assessment tools and case studies	1) Mean knowledge score significantly improved from 23.9 pre-intervention to 27.2 post intervention (out of 30). 2) 42% of participants reported an increase in their ability to provide geriatric care in relation to delirium 3) Increase in proportion of participants who used the MMSE (26.2% to 35.6%), GDS (1.6% to 20.0%) and CAM (1.6% to 11.7%) 4) Increased implementation of geriatric protocols of care in emergency departments (21% post intervention compared to baseline of 12%)	3 months	Emergency
Devlin 2007	USA	Before and after intervention	25 physicians	100 medical intensive care unit inpatients	Face-to-face education 1) One-on-one educational session between study target and validated judge, consisting of a 20-slide multimedia presentation reviewing sedation assessment using the Sedation-Agitation Scale, and delirium evaluation using the Intensive Care Delirium Screening Checklist (ICDSC)	1) Improvement in agreement between physicians and validated judge after ICDSC use, from 0 out of 5 patients to 8 out of 11 patients.	Not described	ICU
Detroyer 2016	Belgium	Pilot study, Before and after intervention	68 nurses, 2 physiotherapists, 2	All inpatients in participating medical, surgical, geronto-psychiatric and	E-learning	1) 67.8% completed more than half the modules, and 44.1% completed all the modules.	2 months	General

			occupational therapists	rehabilitation units	1) Online self-directed delirium educational tool (www.deliriummodule.be), consisting of 11 modules	2) Statistically significant increased rate of delirium detection in post-test phase (64.9% vs 45.6% for hypoactive delirium and 93.0% vs 71.9% for hyperactive delirium) 3) Significantly increased mean total Delirium Knowledge Quiz from 28.3 pre-test to 31.7 post-test (out of 35). 4) No difference in strain in caring for delirious patients post-test and pre-test		
Hickin 2017	Canada	Quasi-experimental single group before and after intervention	125 permanent certified critical care nurses working in ICU	Not described	Face-to-face education 1) PowerPoint presentations incorporating information on delirium, patient testimonial, the ICDSC and procedures for using the screening tool were emailed to participants and posted on a SharePoint site	1) Significant increase in knowledge scores (out of 10) from baseline (6.0) to 3 months (7.2), however not sustained at 18 months (5.3) 2) Significant increase in rate of screening for delirium from 4.14 out of 7 pre-intervention, to 15.94 out of 17 post intervention	18 months	ICU
Kang 2016	South Korea	Single group before and after intervention	40 nurses	Not described	Face-to-face education 1) Two 1.5 hour workshops for 1 month followed by two 50-minute support sessions for 2 months, with learning methods utilised including patient scenarios, role-playing, discussion, lectures and self-directed study 2) Course material included delirium, dementia, assessment and risk factor management, and delirium information for family caregivers	1) Increase in scores on nurses' recognition of cognitive impairment (out of 5) to 3.75 post-intervention from 2.47 pre-intervention 2) Significant increase in number of staff deciding to contact the physician on-call for management of hypoactive delirium (from 16 to 24), and decrease in number of staff contacting the physician for medication in hypoactive delirium (from 14 to 8).	3 months	General
Law 2009*	Australia	Randomised, double blinded control study comparing usual care to staff receiving education package	All nurses in interventional ward	Inpatients	Face-to-face education 1) 30-minute teaching sessions on i) drug treatment of delirium; ii) Confusion Assessment Method; iii) MMSE; iv) Behavioural and psychological symptoms of dementia; v) Psychiatric liaison service; vi) Communication skills	1) Recognition of delirium by ward staff in intervention group not improved (0/1 post-intervention vs 3/5 pre-intervention);	Not described	General

Mistraletti 2016	Italy	Multi centre, randomised, controlled, before and after study	374 Staff nurses and physicians	Not described	<p>Face-to-face education and e-learning</p> <p>1) E-learning website (www.sedaicu.it) providing 14 lessons, 105 papers, 22 ready-to-use instruments and 11 videos.</p> <p>2) Flowchart/pocket cards/posters for pain, sedation and delirium management in ICU were made available</p> <p>3) Three Continuous Medical Education courses were offered (1 of the courses was in delirium evaluation), with each course comprising several lessons, including a two-page text summary, and full text references from international literature</p>	<p>1) Percentage of delirium assessments increased significantly (from 0% to 78.6%), accompanied by a decrease of “missing assessments” for delirium (from 69.2% to 6.3%) which was also significant.</p> <p>2) Significantly less staff members said that they had done no validated delirium screening tools (from 50.5% pre-intervention to 25.7% post-intervention)</p> <p>3) Significant increase in percentage of staff having knowledge of the correct definition of delirium (from 64.9% to 82.7%), and estimates of the prevalence of delirium significantly increased (from 10% to 20%)</p> <p>4) Increase in awareness of CAM-ICU (from 52.5% to 85%), and CAM ICU was more frequently judged to be effective (from 43.1% to 70.4%).</p>	6 months	ICU
Pizzacalla 2015	Canada	Before and after intervention	2 clinical nurse specialists, 80% of 90 staff in an inpatient orthopaedic unit	Inpatients in a 32-bed orthopaedic unit, primarily with a fractured hip	<p>Face-to-face education</p> <p>1) 2 clinical nurse specialists attended the Gentle Persuasive Approaches (GPA) coach training workshop to become certified coaches</p> <p>2) Coach-led 1-day workshop consisting of 4 modules:</p> <ul style="list-style-type: none"> i) person-centered care and finding the meaning behind the behaviour ii) discussion on dementia and delirium, and the resulting care implications and strategies of care iii) communication strategies and techniques to use for caring for persons with dementia and delirium iv) suitable or respectful self-protective physical techniques and body containment strategies 	<p>1) Significant improvement in self-confidence scores reported after the intervention on the following comments (on a 7-point Likert scale):</p> <ul style="list-style-type: none"> i) ...can figure out why they are reacting in a challenging way (from 4.13 to 5.42) ii) ...can identify triggers that result in challenging behaviour (from 3.96 to 5.35) iii) ... will back off momentarily when you sense that they become agitated (from 4.71 to 5.94) iv) can ensure a calm environment (from 4.14 to 5.57) v) ... can use an alternative strategy (from 3.68 to 5.35) vi) can appropriately use self-protective techniques (from 3.69 to 5.81) vi) ...know what communication strategies to use (from 4.08 to 5.73) 	Not described	General

					3) Course material including slides, video clips, demonstrations and experiential exercises	vii) ...know how to divert the patient's anxiety (from 4.19 to 5.86) 2) Observation that Code Whites (violent situation) were being called less (1 incident in 12 months post intervention compared to 11 incidents in the previous year) 3) Staff observation that there was less use of Pinel Restraints		
Radtke 2012	Germany	Prospective cohort study comparing regular standard training with modified extended education	Nurses and physicians working in 3 surgical ICUs	619 ICU inpatients, >18 years of age, spending at least 3 days in ICU	Face-to-face education 1) Standard regular training – lectures, instructional video, handouts and bedside teaching 2) Modified extended training – 3 consecutive repetitive cycles of standard regular training with further elaboration on the theoretical background of delirium, practical aspects of monitoring, a discussion session after bedside teaching, and the presence of a support team consisting of 2 nurses and a physician	1) Frequency of delirium monitoring significantly increased in the group receiving modified extended training (from 0 times/patient/day to 1.6 times/patient/day), and this effect was sustained on 1 year follow up (1.8 times/patient/day) 2) No changes in frequency of delirium monitoring in the group receiving standard training (0 times/patient/day), with a significant increase after this group received modified extended training (1.4 times/patient/day)	12 months	ICU
Ryan 2009	Ireland	Comparison between pilot phase and main phase of CAM validation	Non-consultant hospital doctors	Patients admitted to the palliative care unit who were not actively dying, conscious, and able to communicate	Face-to-face education 1) 1-hour training session involving one-one sessions with mock interviews, 4 pilot interviews with patients, inter-rater reliability assessments and special coding sessions (pilot phase) 2) 2 one-hour training sessions involving case-based learning, followed by a multiple-choice questionnaire in addition to the above (main phase)	1) Increase in sensitivity of the CAM from 0.5 in the pilot phase to 0.88 on the main phase 2) Decrease in false negative diagnosis of delirium from 6 cases in the pilot phase to 2 cases in the main phase	Not described	Palliative Care
Sockalingam 2016	Canada	Before and after intervention	82 nurses, 10 occupational therapists, 5 physiotherapists	Not described	Face-to-face education 1) Pre-work phase involving a delirium e-learning module, a self-assessment test, and an online video demonstrating a delirium assessment using the CAM, together with a	1) 90% of participants rated their satisfaction with the training session as “very good” or “excellent”. 2) Significant increase in delirium test scores from 7.8 pre-intervention to 9.7 post-	6 months	General

			sts, 5 respiratory therapists, 3 social workers, 2 dieticians, 2 spiritual care workers, 2 psychologists, 1 physician, 26 clinical practice education leads, 18 clinical administration leads		pre-session survey and delirium knowledge test 2) 3-hour session facilitated by an interprofessional team consisting of 5-6 health care professionals (at least 2 physicians and 1 computer user support specialist) with 25 participants, with the session involving reflection on delirium care, a micro-lecture on delirium resources and online delirium screening tool, video case exercise on delirium assessment, and case-based learning on delirium management	intervention, with no decay in scores when the test was repeated 6 months later. 3) Significant increase in the number of CAM assessments (66% post-intervention vs 53% pre-intervention)		
Solberg 2013	USA	Quality improvement, before and after multi-component intervention	39 staff nurses	Patients over the age of 65 years, admitted to the ACE unit with a length of stay of more than 1 day	Face-to-face education 1) 1-hour teaching session including a delirium pre-test, education on delirium assessment techniques which involved symptom recognition of delirium using a web-based video, instructions on completing the Nu-DESC, practice sessions using case vignettes, and the ACE delirium protocol 2) Bi-weekly rounds with the geriatrician or advanced practice nurses 3) Voluntary informational session for internal medicine residents	1) Significant increase in shifts where neurocognitive assessments were carried out, from 70% (pre-intervention) to 77% (post-intervention) 2) Significant increase in proportion of inpatients who had neurocognitive assessments from 95% (pre-intervention) to 99% (post-intervention) 3) Significant increase in shifts with documentation of "delirium, "acute confusion" and "acute change in mental status" from 0% (pre-intervention) to 13% (post intervention) 4) Significant increase in nurse notification of abnormal cognitive status/behaviour to physicians, from 31% (pre-intervention) to 48% (post-intervention) 5) Significant increase in proportion of physician ordered delirium work up or treatment in response to nurse notification	5 months	Geriatric

						from 54% (pre-intervention) to 90% (post-intervention)		
Swan 2014	USA	Before and after intervention	Nursing staff working in surgical ICU	All patients admitted to surgical ICU over the study period	<p>Face-to-face education</p> <p>1) 10 minutes of 1-on-1 instruction from a nurse educator, with the first 5 minutes reviewing general concepts of the CAM-ICU assessment process, and the final 5 minutes reviewing a 2-page educational brochure containing a process map emphasising the importance of categorizing patients before starting the CAM-ICU</p>	<p>1) Overall incidence of CAM-ICU rated as “inappropriate” significantly decreased from 19% (pre-intervention) to 5% (post intervention)</p> <p>2) Significantly more CAM-ICU ratings were documented per patient (7 post-intervention vs 4 pre-intervention)</p> <p>3) In patients receiving mechanical ventilation, the incidence of inappropriate CAM-ICU ratings decreased from 70% (pre-intervention) to 44% (post intervention).</p>	Not described	ICU
Tkacheva 2016	Russia	Before and after intervention	6 residents in internal medicine	Patients aged over 65 years old who were hospitalized and able to consent to participate	<p>Face-to-face education</p> <p>1) 1-hour course including a short lecture of 20 minutes on delirium, followed by training in the use of CAM-ICU and the Barthel Index</p>	<p>1) Out of 181 patients included in the study, the residents diagnosed 13 cases of delirium (7.2%) of which nine (69.2%) were hypoactive, whereas prior to intervention the diagnosis of delirium was never made.</p> <p>2) In the discharge letters of the 13 patients with delirium, the diagnosis “delirium” or any related diagnosis was not included, and in six letters there was no mention of the patient’s cognitive state.</p>	Not described	General

Table 4 Overview of Kirkpatrick Level 4 studies (Negative studies are marked with *)

Reference	Country	Study Design	Study targets	Study population (including age)	Educational interventions	Findings	Sustainability	Setting
Detroyer 2018*	Belgium	Before and after intervention	17 nurses in the geriatric ward	160 Dutch speaking patients over 70 years old admitted to the geriatric ward	E-learning 1) Online self-directed nursing staff educational program on delirium consisting of 11 modules on delirium prevention, treatment strategies, screening tools (www.deliriummodule.be), with 1 hour live session offering information about navigation of the modules 2) Poster display on the geriatric ward	1) No difference in the overall proportion of delirious patients in the intervention cohort (21.5%) vs the control cohort (25.9%) 2) No significant differences in the proportions of nurses able to correctly identify hyperactive delirium (82.4% vs 88.8%), hypoactive delirium (52.9% vs 64.7%) and delirium superimposed on dementia (94.1% vs 58.8%) before and after the intervention 3) No difference in delirium knowledge quiz score post-intervention (29.9) compared to pre-intervention (29.3) out of 35	4 months	Geriatric
Eeles 2013	Australia	Before and after multi-component intervention	Nursing staff (AINs)	Inpatients with a diagnosis of delirium made by nursing staff using the CAM accompanied by a Pittsburgh Agitation Rating Scale of >2, and a high falls risk	Face-to-face education 1) Full day training and education programme for the management of patients with delirium delivered by nurse educators including presentations on: definitions of delirium and dementia, environmental considerations, communication styles, practice partnership models of care and Close Observation Unit (COU) operation	1) Significant improvement in inpatient mortality rates due to delirium (5%) compared to the previous year (14.3%)	Not described	Geriatric

Hasemann 2016	Switzerland	Comparison study between usual treatment and a multicomponent interventional package for delirium (DemDel)	Registered nurses and physicians in participating general medical wards	Inpatients above 70 years old with signs of cognitive impairment	<p>Face-to-face education</p> <p>1) 1-day training session about delirium prevention, treatment, screening, and cognitive impairment for nurses</p> <p>2) Two 30-minute lectures on delirium management for physicians</p> <p>3) Monthly 30-minute case conferences providing nurses with an opportunity to reflect on current delirium management issues</p>	<p>1) Mean delirium severity scores using DRS-R-98 in adherent wards were significantly lower compared to non-adherent wards and wards practising usual care, actual mean scores not described</p> <p>2) No significant difference between duration of delirium between intervention group (3.0 days) and control group (4.1 days)</p> <p>3) Significant decrease in lorazepam prescription in the intervention group (2 days of medication) compared to the control group (17 days of medication)</p>	Not described	General
Lundström 2007	Sweden	Randomised control study comparing postoperative care in a specialized geriatric ward to a conventional orthopaedic ward	Registered nurses, licensed practical nurses, registered physiotherapists, dieticians, geriatricians	Inpatients aged over 70 years admitted with a femoral fracture without severe rheumatoid arthritis, severe hip osteoarthritis, severe renal failure, pathological fractures, and who were not bedbound prior to admission	<p>Face-to-face education</p> <p>1) A four-day course in caring, rehabilitation, teamwork and medical knowledge, including sessions about how to prevent and treat various postoperative complications including postoperative delirium (risk factors, prevention and treatment, osteoporosis, hip fractures, operation methods, anaesthesia, postoperative care, pain, sleep and sleep apnoea, individual care planning and nutrition.</p>	<p>1) Number of days with postoperative delirium in intervention group was lower (5.0 days) compared with controls (10.2 days)</p> <p>2) A significantly smaller proportion of the intervention group were delirious (56/102) compared to the control group (73/97), and this effect was sustained for 1 week</p> <p>3) A significantly lower prevalence of delirium in the intervention group (18%) compared with the control group (52%)</p> <p>4) No patients in the intervention group were discharged with delirium,</p>	Not described	General

						<p>compared to 20 in the control group.</p> <p>5) Patients in the intervention group with postoperative delirium had less urinary infections (39.3% vs 60.3%), less sleeping problems (28.6% vs 50.7%), less falls (17.9% vs 34.3%) and less decubitus ulcers (10.7% vs 23.6%) compared to the control group</p> <p>6) More assessments of underlying causes of delirium were documented in the nursing records in the intervention ward compared with the control ward.</p> <p>7) Delirious patients in the intervention group were less often given sedatives (15.4% vs 41.7%) and opioid drugs on demand (30.8% vs 61.7%) than those in the control group.</p> <p>8) Intervention patients had shorter total postoperative hospitalization (28.0 days vs 38.0 days) than controls, which was also true for intervention patients with postoperative delirium (31.4 days vs 43.6 days).</p>		
Mudge 2011*	Australia	Concurrent controlled trial	All staff	Patients over 65 years old admitted with an anticipated length of stay over 3 days	<p>Face-to-face education</p> <p>1) Education sessions for all staff</p>	<p>1) No significant reduction in nursing requirements or duration of symptoms for delirious patients</p> <p>2) Participants in the interventional group were</p>	Not described	General

					<p>2) Educational materials provided in a folder placed in each ward</p> <p>2) one-on-one training for nursing assistants and volunteers</p> <p>4) Monthly case-based forum facilitated by a physician</p> <p>5) Regular one-on-one and in-service education</p> <p>6) Nursing protocols for management of the agitated patient</p>	<p>more likely (32%) to seek psychogeriatric consultation vs controls (11%)</p> <p>3) Length of stay for delirious patients were longer in the intervention group (16 days) vs the control group (8 days)</p>		
Vidan 2009	Spain	Prospective controlled trial	Geriatric ward staff	Patients over 70 years old admitted to the geriatric and internal medicine wards	<p>Face-to-face education</p> <p>1) Sessions explaining delirium recognition and risk factors</p> <p>2) Poster in nurses' station with environmental and general prevention measures</p> <p>3) Cards with recommendations included in the first page of the treatment book used by nurses</p>	<p>1) Rate of new episodes of delirium during hospitalization was significantly lower in the intervention group (11.7%) compared to the control group (18.5%)</p> <p>2) In the intervention ward, there were significantly less patients staying in bed longer than 48 hours, less use of physical restraints and a higher rate of patients walking in the ward, using their own glasses or hearing aids</p>	6 months	General
Wald 2011	USA	Quasi-randomised, controlled study comparing ACE unit care with usual ward care	Medical residents	Inpatients aged 70 years and over, not admitted under a subspecialty service, or transferred between another service (e.g. ICU	<p>Face-to-face education</p> <p>1) 13 modules created by the attending hospitalist, of which one module was delirium</p> <p>2) Formal instructional sessions of 30-45 minutes, 3-4 times a week in addition to routine educational conferences</p>	<p>1) Patients admitted under ACE care were significantly more likely to have had recognition and treatment of any abnormal cognitive status (55.78% vs 40.0% for usual care)</p> <p>2) Whilst patients admitted under ACE care were more</p>	Not described	Geriatric

				and orthopaedic surgery)		likely to have recognition and treatment of delirium (27.1% vs 17.0%), this was not significant 3) There were no significant differences in mean length of stay, mean charges, 30-day readmission rate, home discharge destination rate, and falls rate between ACE care and usual care.		
Wand 2014	Australia	Before and after intervention	39 doctors, 35 nurses, 3 other staff members	Patients aged 65 years and over who were not delirious on admission	Face-to-face education 1) 1-hour education sessions for nursing staff conducted by the nurse educator and a psychogeriatrician, and 1-hour weekly education sessions for medical staff conducted by a psychogeriatrician and geriatrician, including general information on delirium, prevention and management of patients with delirium. 2) Weekly tutorials with opportunities to ask questions, discuss cases and receive feedback of clinical practice 3) 1-page summary of key points at the end of each teaching session 4) Display of posters in prominent areas of the study ward	1) Significant improvement in Barthel's score in the post-intervention group (of 5.3 points) compared to the pre-intervention group (1.8 points) 2) Overall incidence of delirium significantly lower in the post-intervention group compared to the pre-intervention group (10.1% vs 19%) 3) Statistically significant improvement in staff confidence in addressing and managing risk factors for delirium and accessing help managing patients with delirium 4) Significant improvement in staff performance on 15 item delirium knowledge test 5) Significant increase in number if delirium risks addressed by clinical staff (from 8.1 per patient pre-intervention to 9.8 post	Not described	General

						intervention, out of a possible 13 risk factors)		
--	--	--	--	--	--	---	--	--