Preventing Delirium Takes a Village: Systematic Review and Meta-analysis of Delirium Preventive Models of Care

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BACKGROUND: Each hospital day of delirium incurs greater healthcare costs, higher levels of care, greater staff burden, and higher complication rates. Accordingly, administrators are incentivized to identify models of care that reduce delirium rates and associated costs.

PURPOSE: We present a systematic review and meta-analysis of delirium prevention models of care.

DATA SOURCES: Ovid MEDLINE, CINAHL, Cochrane Database of Systematic Reviews, EMBASE, and PsycINFO.

STUDY SELECTION: Eligible models of care were defined as provider-oriented interventions involving revision of professional roles, multidisciplinary teams, and service integration. Included studies implemented multidomain, multicomponent interventions, used a validated delirium instrument, and enrolled a control group to evaluate efficacy or effectiveness.

DATA EXTRACTION: We extracted data on study design; Population, model of care, outcomes, and results.

DATA SYNTHESIS: A total of 15 studies were included. All but two studies reported reduction in delirium or its duration, and 11 studies reported statistically significant improvements. Using random effects models, the pooled odds ratios of delirium incidence were 0.56 (95% CI: 0.37-0.85) from three randomized controlled trials, 0.63 (95% CI 0.37-1.07) from four pre–post intervention studies, and 0.79 (95% CI: 0.46-1.37) from three additional nonrandomized studies.

CONCLUSIONS: Several models of care can prevent delirium. In general, higher quality studies were more likely to demonstrate statistical significance of an effect. The diverse models of care included here explored interventions adapted to specific care settings, especially by addressing setting-specific delirium risk factors. These care models illustrate a range of promising strategies that deserve growing recognition, refinement, and implementation. *Journal of Hospital Medicine* 2019;14:558-564. Published online first May 10, 2019. © 2019 Society of Hospital Medicine

D elirium presents as an acute change in mentation characterized by reduced attention, clouding of awareness, and typically an altered level of arousal. It can be caused by a host of medical conditions, medications, or other psychoactive substances and is therefore encountered primarily in acute and postacute medical settings.[1] More than a quarter of all hospitalized patients develop delirium,[2] with rates up to 80% in the critically ill.[3] Similarly, delirium occurs in more than one-third of patients who transition to postacute care.[4] These high prevalence rates are alarming, especially because delirium is a risk factor for mortality; Prolonged hospitalization, institutionalization, and overall higher cost of care.[5] However, more than a quarter of delirium is preventable.[6] Evidence-based guidelines for delirium uniformly call for multicomponent prevention strategies,[7] and these are best delivered through collaborative models of care. In short, delirium impacts healthcare systems; therefore, interventions aimed at preventing delirium and its consequences ought to be systems-based.

Since the Institute of Medicine issued its 1999 report highlighting the critical role of medical errors in healthcare, healthcare systems have increasingly become team-based.[8] "Medical care is inherently interdependent,"[9] and this implies that delirium prevention rests not only on individuals but also on broader systems of care. Although nonpharmacological interventions are efficacious at preventing delirium,[10] previous reviews have focused on specific interventions or multiple interventions rather than the systems of care needed to deliver them. Indeed, teams and the quality of their teamwork impact outcomes.[11]

Herein, we provide a systematic review and meta-analysis of integrated models of care designed to prevent delirium. What distinguishes this review from previous reviews of nonpharmacological interventions to prevent delirium is our focus on discrete models of care that involve collaboration among

clinicians. Our goal is to identify the most promising models that deserve further development, investigation, and dissemination. Viewing delirium prevention through a collaborative care lens is consistent with efforts to achieve value-based care and may encourage drawing from the expanding literature outlining the benefits of mental healthcare integration.[12,13] Specifically, a systems perspective highlights the potential for system-wide benefits such as reducing readmissions[14,15] and cost savings.[16]

METHODS

This systematic review and meta-analysis follows PRISMA guidelines. A search of OVID, MEDLINE, CINAHL, Cochrane Database of Systematic Reviews, EMBASE, and PsycINFO was completed by a medical librarian for clinical studies in which models of care were implemented to prevent delirium using PICO (P patient; Problem or population; I, intervention; C, comparison, control or comparator; O, outcome) inquiries. Search terms included delirium, acute confusional state, altered mental status; Prevention, and control ("delirium"/exp OR "acute confusion"/exp OR "altered mental status"/exp) AND "prevention and control"/exp AND [English]/lim AND [embase]/lim).

One researcher (AK) screened articles by title for relevance. Relevant articles were then divided among four authors (AK, MO, NF, and OB), and the abstracts were screened for eligibility. The authors reviewed the full texts of any potentially eligible studies. Each full text was assigned to two authors for full review. Discrepancies were adjudicated by conference among all authors. In addition, references within all full-text publications were scanned for potential additional articles.

The inclusion criteria for review of full-text articles required English-language description of a model of care with multiple interventions, delirium reported as an outcome, and presence of a comparator group.

"Model of care" was defined by the Cochrane Effective Practice and Organization of Care Review Group as follows: (1) revision of professional roles, including shifting of professional roles or expansion of roles to new tasks; (2) creation of clinical multidisciplinary teams or addition of new members to the team who collaborate inpatient care; (3) delivery of multiple interventions across multiple domains (ie, studies involving a single intervention such as physical therapy or targeting a single domain such as sleep were excluded); and (4) formal integration of services whereby teams work together in collaboration with existing services to enhance care.[17] For this review, we required that studies include a comparator group so that effectiveness of the intervention could be assessed. Quality improvement studies that lacked a comparator group were excluded.

Delirium incidence was the primary outcome and was evaluated by meta-analysis. Heterogeneity was assessed using I^2 and visual inspection of forest plots. I^2 values of 25%, 50%, and 75% represent low, moderate, and high heterogeneity, respectively. The studies were pooled according to study type as follows: randomized controlled trials; Pre–post design, and other nonrandomized prospective studies. Random effects models

were used to calculate estimates using the Comprehensive Meta-Analysis software (Version 3, Biostat, Englewood, New Jersey), which also generated forest plots.

Risk of bias was assessed using criteria established by the Cochrane Collaborative Review Criteria, which lists six categories of potential bias: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, and selective reporting.[17] Each study was assessed by two authors (either MO and AK or MO-P and OB) for bias and a numerical value was assigned to each of the six categories as follows: 1 = low risk, 2 = unknown/moderate risk, and 3 = high risk. Where scorers disagreed, all authors jointly conferred, and a consensus score was given. The values for each of these six categories were added to create a composite risk-of-bias score for each study, with 6 being the lowest possible score and 18 the highest. Overall risk was classified as follows: <9 = low risk, 9-12 = moderate risk, and >12 = high risk.

RESULTS

Study Selection Process

An initial literature search identified 352 articles. After reviewing the titles, 308 articles were excluded for irrelevance, and 44 abstracts were screened for eligibility. We excluded 27 articles upon abstract review, and the full texts of 17 were obtained for detailed review. In addition, we identified another 10 potentially eligible articles through review of references and obtained full texts of these as well. Of the 27 full-text articles reviewed, 15 were included in this systematic review, 10 of which were suitable for meta-analysis. The Figure shows the PRISMA flow chart.

Study Characteristics

The 15 studies that met the inclusion criteria are summarized in the Table.[18-32] Delirium prevention was among the primary outcomes of 13 studies; delirium outcomes were reported in the other two studies as well, which were primarily designed to assess feasibility.[26,27] Six studies were conducted in the United States, three in Sweden, two in Spain, two in the United Kingdom, and one each conducted in Korea and Canada. Healthcare settings among the included studies involved the intensive care unit (six studies), medical floors (four studies), surgical floors (three studies), a long-term care unit (one study), and an inpatient palliative care service (one study). We categorized the studies according to design and intent as follows: randomized controlled studies (three); Pilot feasibility studies (two); Pre–post design (six), and other nonrandomized prospective studies (four; Table).

Outcomes Reported

All but one of the studies reported delirium incidence. The most commonly used delirium screening instrument was the Confusion Assessment Method (CAM) or its modified version, the CAM-ICU (11 studies).[33,34] Other methods used to assess mentation included the Richmond Agitation Sedation Scale,[35]

the Organic Brain Syndrome scale,[36] the revised Delirium Rating Scale,[37] the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition,[38] and the Confusion Rating Scale.[39] (Details regarding delirium screening tools can be found in the systematic review by De and Wand.[40]) Researchers performed delirium assessment in nine studies, whereas assessments were performed by clinical staff in the remaining studies. Other outcomes reported included length of stay (LOS), mortality, number of days ventilated, and functional decline. None of the included studies reported cost effectiveness.

Risk of Bias Assessment
Risk of bias assessment identified only two studies—both randomized controlled trials—as low risk (Table). The remaining studies had moderate (four studies) or high risk (nine studies).

Results from Individual Studies
Of the 15 studies, nine reported a statistically significant reduction in delirium incidence, and another two reported a statistically insignificant reduction. In addition, seven of the eight studies that assessed delirium duration found reduced duration in the intervention cohort, and two of the three studies that reported delirium severity found a reduction in the intervention group.

Results of Meta-Analysis
Random effects models were created to meta-analyze groups of studies based on design as follows: randomized controlled trials (three studies[18,19,25]); Pre–post intervention studies (four of six studies included[28-31]), and other nonrandomized studies (three of four studies included[21-23]). Meta-analysis was not completed for the two feasibility studies[26,27] because delirium outcome data were limited due to the feasibility study design. The study of Dale et al.[32] was excluded from the meta-analysis because the rates of CAM-ICU completion differed substantially between control and intervention groups (0.35 vs 1.49 per 24 hours, respectively), leading to imbalanced between-group sensitivity in delirium detection and Needham et al.[20] was also excluded because it reported only days of delirium, not delirium incidence. The study by Lundström et al.[24] was also excluded from the meta-analysis because delirium incidence was measured on days 1, 3, and 5, whereas the other studies reported delirium daily.

Meta-analysis of the three randomized controlled trials revealed a pooled odds ratio of 0.56 (95% CI: 0.37-0.85; P = .006) for delirium incidence among intervention group subjects relative to those in comparator groups. The heterogeneity across studies was low (I^2 = 29%). Pooling data from four pre–post studies found that the odds ratio for delirium incidence was 0.63 (95% CI: 0.37-1.07; P = .09). The heterogeneity
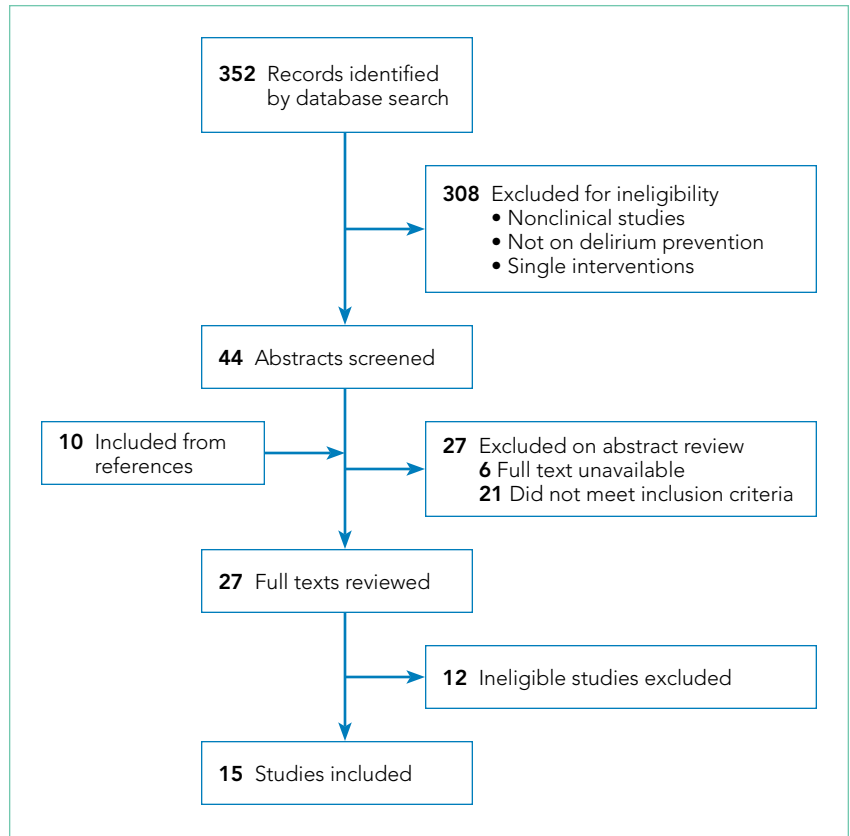

FIG 1. PRISMA flow chart.

across these studies was moderate (I^2 = 65%). Results from the three eligible, nonrandomized prospective studies were also pooled. The odds ratio for developing delirium among study subjects was 0.79 (95% CI: 0.46-1.37; P = .40), and the heterogeneity among these studies was high (I^2 = 85%).

DISCUSSION
We provide a systematic review and meta-analysis of delirium preventive models of care. Meta-analysis of the three randomized controlled trials found that these models of care led to a statistically significant reduction in delirium incidence; study subjects had an 11.5% reduction in absolute delirium incidence. The pooled odds ratios for both of the other sets of nonrandomized studies favored the intervention group but were not significant, each because of one included study. The pre–post meta-analysis failed to reach significance as one of the included studies found a trend toward higher delirium incidence; however, interestingly, in that same study, the overall delirium-free days were significantly reduced overall (24 vs 27; P = .002). Similarly, meta-analysis of the three additional nonrandomized prospective studies failed to reach significance because the largest included study found higher rates of delirium among intervention group subjects. Despite considerable risk of bias in several of these studies, their findings were broadly consistent; all but one study (Gagnon 2012[21]) reported a trend or a significant reduction in delirium incidence, duration, severity, or number of delirium episodes. Moreover, the

TABLE. **Overview of Included Studies**

Reference	Design, Delirium Assessment (Risk of Bias)	Study Population	Model of Care	Outcomes and Results
RANDOMIZED CONTROLLED TRIALS				
Moon & Lee, 2015[18]	Single-blind RCT, CAM-ICU by research nursing (moderate)	*N* = 123; **Setting:** ICU, Korea; **Inclusions:** age ≥ 18 years, ICU ≥48 hours, consent; **Exclusions:** persistent RASS of -4/-5/+3/+4, severe neuropsychiatric diagnosis.	**Elements:** delirium risk screen, cognitive assessment, environment intervention; **Team:** 4 researchers, ICU nursing, both of whom collaborated with ICU physicians.	Trend for delirium reduction (33% vs 20%; *P* = .1) with reduction in hospital mortality (7% vs 21%; *P* = .02)
Lundström et al., 2007[19]	RCT, OBS scale with MMSE by trained study nurse (low)	*N* = 199; **Setting:** specialized geriatric ward vs conventional orthopedic ward. Sweden. **Inclusions:** ≥70; postop**.**	**Elements:** staff education; Prevent complications, analgesia, sleep hygiene, nutrition, and early rehabilitation, mobilize, and reduce invasive procedures (ie, Foley); **Team:** integrated nursing; Physical therapy; Practitioners.	Delirium reduction (75% vs 55%; *P* = .003), fewer days delirious (5 vs 10 days), shorter hospital stay (28 vs 38), fewer complications.
Vidán et al., 2005[1]	Double-blind RCT, CAM by research staff (low)	*N* = 319; **Setting:** general hospital, Spain; **Inclusions:** age ≥65 years; to undergo acute hip fracture surgery; **Exclusions:** inability to walk before the fracture; dependency in all basic ADLs; pathological hip fracture; and known terminal illnesses with life expectancy of <12 months.	**Elements:** geriatric evaluation for medical and psychosocial problems; comprehensive therapeutic plan, weekly team meetings of orthopedic and geriatric teams. **Team:** geriatrician, rehab specialist, social worker, orthopedic surgeon, and nurse.	Marginally significant delirium reduction (44.1% vs 34.2; *P* = .07).
PILOT FEASIBILITY STUDIES				
Rice, et al., 2017[20]	Pilot feasibility RCT, CAM by clinician and researcher (high)	*N* = 125; **Setting:** neuro ICU and stroke unit; USA **Inclusions:** age >50 years; acute stroke; **Exclusions:** subdural hematoma, non-English speaking; Prevalent delirium, aphasia, medically unstable.	**Elements:** 15 minutes daily activity by trained volunteer and prescribed by speech therapy; medication review; **Team:** coordination between speech therapist and trained volunteers; Pharmacist to review anticholinergic burden.	Delirium reduction (11% vs 5%; *P* < .05)
Siddiqi et al., 2016[21]	Cluster RCT for feasibility, CAM by research staff (high)	*N* = 160; **Setting:** 14 long-term care homes in UK; **Exclusions:** communication difficulties, non-English speaking, end-of-life care.	**Elements:** 16-month educational protocol (Stop Delirium!) that identified a Delirium Champion, trained care home staff, and implemented the Delirium Box; **Team:** all home staff.	Delirium reduction (7% vs 4%; *P* < .05)
PRE–POST INTERVENTIONS				
Bryczkowski et al., 2014[22]	Prospective pre- or postintervention cohort study, CAM-ICU by clinicians (high)	*N* = 123; **Setting:** 14-bed SICU, academic level I urban trauma center in USA; **Inclusions:** age >50 years, admitted to SICU for ≥24 hours; **Exclusion:** ≥ moderate traumatic brain injury, jail/police custody, dementia.	**Elements:** pharm protocol (limit deliriogens), nonpharm protocol (sleep consolidation, daytime light box, scheduled daily quiet times, massage therapy); Patient and family education (feeding, gentle massage, and reorientation); **Team:** practitioners, nurses; Physical therapists, and nursing assistants; collaboration along with family involvement.	Insignificantly higher rate of delirium after intervention: 47% vs 58% (*P* = .26) but increase in delirium-free days: 24 vs 27 (*P* = .002), more vent-free days 21 vs 25 (*P* = .03) and shorter LOS in ICU and total in-hospital.
Holt et al., 2013[23]	Prospective pre–post study, CAM and DRS-R-98 daily by blinded research personnel (moderate)	*N* = 436; **Setting:** Elderly care ward at general hospital elderly care department (3 units) in UK; **Inclusions:** consecutive admissions **Exclusions:** baseline delirium, "too unwell," unable to communicate.	**Elements:** Standardized education and delirium risk factor modification protocol materials; identify opinion leaders or "champions" to lead implementation; educational intervention to raise awareness, knowledge, and enthusiasm; practice change to reduce risk factors; **Team:** coordination between nurses and physicians to identify escalation of delirium risk and care changes.	Delirium reduction: 13.3% vs 4.6% (*P* = .006). Duration and severity of delirium reduced but with small magnitude of effect; higher readmission rates in intervention group (54.1% vs 41.1%; *P* = .02).
Björkelund et al., 2010[24]	Pre–post study, OBS scale by staff (high)	*N* = 263 (131 intervention, 132 control); **Setting:** Patients admitted to the hospital with hip fracture in Sweden; **Inclusions:** consecutive patients with hip fracture, cognitively intact on admission; **Exclusions:** age <65 years, dementia, neuropsychiatric illness, communication difficulties and multitrauma.	**Elements:** supplemental oxygen, IV fluid and nutrition, increased monitoring of vital signs; Pain relief, no delays in transfer logistics, screen for delirium daily, avoid polypharmacy; Perioperative/anesthetic period adjustment, education; **Team:** integration of prehospital care and collaboration among nurses and physicians.	Delirium reduction (34% vs 22%; *P* < .05).
Balas et al., 2014[25]	Prospective pre–post study, CAM-ICU in routine care (high)	*N* = 296; **Setting:** ICU, step-down, and heme/onc specialty care unit; USA; **Inclusions:** intubated and nonintubated patients; **Exclusions:** no legally authorized representative to provide consent within 48 hours of admission.	**Elements:** (ABCDE bundle): daily spontaneous awakening and breathing trials that are coordinated, delirium monitoring, early mobility; **Team:** daily coordination among nursing, respiratory therapist; Physical therapist, and practitioners.	Delirium reduction (62% vs 49%; *P* < .05); shorter delirium duration by one day; lower % of ICU days delirious (33% vs 50%; *P* < .05); fewer median vent days (24 vs 21; *P* < .05).

TABLE. Overview of Included Studies (continued)

Reference	Design, Delirium Assessment (Risk of Bias)	Study Population	Model of Care	Outcomes and Results
PRE–POST INTERVENTIONS				
Dale et al., 2014[26]	Pre–post study, CAM-ICU by nursing staff (high)	N = 1,483; **Setting:** 24-bed trauma-surgical ICU in USA; **Inclusions:** admitted to trauma or surgical ward and have mechanical ventilation.	**Elements:** pain and sedation management and nursing nonpharm interventions (manage environment, hearing aids/glasses, blinds, noise, mobilize, monitor for adverse medication effects, medication orders, document interventions); **Team:** daily coordination between nurses, respiratory therapists, and physicians.	Increase in delirium incidence (22.6% vs 10.7%) in intervention (due to much higher rates of CAM-ICU completion) but reduction in delirium days by 3.9% (21.2% vs 25.1%; $P < .01$) and overall OR of delirium on a per-12-hour basis in the first 16 days of ICU stay was 0.67 (95% CI: 0.49-0.91; $P = .01$) versus baseline.
Needham et al., 2010[2]	Pre–post study, RASS, CAM-ICU by clinical staff (high)	N = 57; **Setting:** 16-bed MICU in an academic hospital; USA; **Inclusions:** mechanical ventilation ≥4 days.	**Elements:** education, raise default activity level, reduce sedation, safety, simplify guidelines for OT, PT consultation, increase staffing, increase neurologist consultations; **Team:** coordination among representatives from each relevant clinician group in the MICU and PM&R.	Significant reduction in % of days delirious (36% vs 28%, $P = .003$) after intervention. Delirium incidence not reported.
PROSPECTIVE STUDIES				
Gagnon et al., 2012[27]	Nonrandomized clinical trial, Confusion Rating Scale by nursing each shift (high)	N = 1,516; **Setting:** 7 terminal cancer inpatient palliative care units, Canada; **Exclusions:** delirious on admission or within 48 hours of admission, hospitalized in <48 hours or >90 days and still alive at discharge.	**Elements:** research team notified physician about high-risk factors; bedside nurse notified to orient the patient daily; bedside nurse educated family regarding delirium prevention; **Team:** physician, nurses, family, and researchers.	Delirium increase (49% vs 44%) in intervention compared to usual-care group; delirium incidence higher in intervention group than in usual-care group (OR 1.23); no difference in delirium severity, duration of first delirium episode, total number of delirium days, delirium-free survival time.
Inouye et al., 1999[28]	Prospective clinical trial with individual matching, CAM + MMSE and Digit Span Test by blinded research personnel (moderate)	N = 852; **Setting:** general medicine; USA; **Inclusions:** age ≥70 years, not delirious on admission, intermediate or high risk for delirium; **Exclusions:** inability to participate, hospital stay ≤48 **hours**; Prior study enrollment.	**Elements:** cognitive impairment, sleep disruption, immobility, visual impairment, hearing impairment, dehydration; **Team:** coordination among geriatric nurse specialist, two elder life specialists, certified therapeutic recreation specialist; PT consultant, geriatrician, and volunteers.	Reduction in delirium incidence: 5.1% (OR 0.6, 95% CI: 0.39-0.92) with fewer total days delirious (56 days) and fewer delirium episodes (28 episodes). No difference in severity or recurrence.
Vidán et al., 2009[29]	Prospective, controlled trial, enriched CAM by researcher (high)	N = 542; **Setting:** geriatric unit, two medical units, Spain; **Inclusions:** age ≥70 years, not delirious on admission + at least one delirium risk factor (cognitive impairment, visual impairment, acute disease, dehydration); **Exclusions:** severe dementia, coma, expected hospital stay ≤48 hours.	**Elements:** QI program with education targeting seven domains (orientation, vision/hearing, sleep preservation, mobilization, hydration, nutrition, drug list review) and implementation; **Team:** a geriatric nurse coordinated a team of nurses, residents, and geriatricians and also monitored adherence.	Reduction in delirium incidence (6.8%; $P = .04$) and reduced severity and duration (2.5 hours). No difference in recurrence, functional decline, or death.
Lundström et al., 2005[30]	Prospective study, OBS scale, DSM-IV by trained research assistant (moderate)	N = 400; **Setting:** general internal medicine hospital, Sweden **Inclusions:** age >69 years; **Exclusions:** refusal to participate.	**Elements:** Medical team education, reorganization of nursing staff from a task-allocation care to patient-allocation individualized care, monthly guidance for nursing staff. **Team:** coordination between nursing, medical staff, education by nurse researchers.	Delirium equally common on admission but fewer delirious patients in intervention (30.2%) than control ward (59.7%) on day 7; shorter LOS in delirious patients in the intervention than control ward (10.8 ± 8.3 vs 20.5 ± 17.2 days).

Abbreviations: CAM, Confusion Assessment Method; CI: confidence interval; DRS-R-98, Delirium Rating Scale-Revised-98; HELP, Hospital Elder Life Program; ICU, intensive care unit; LOS, length of stay; LTC, long-term care; MICU, medical ICU; MMSE, Mini Mental State Examination; OBS, organic brain syndrome; OR, odds ratio; PM&R; physical medicine and rehabilitation; PT; physical therapist; QI, quality improvement; RASS, Richmond Agitation and Sedation Scale; RCT, randomized controlled trial; RN, registered nurse, RT, respiratory therapist; SICU, surgical ICU; vent, ventilator.

value of such models of care extended beyond preventing delirium; for instance, other positive outcomes included reduced LOS and fewer medical complications.

Models of care ranged widely with respect to specific interventions, though several common elements highlighted their relevance for delirium care and as potential delirium prevention strategies in future studies. For example, two of the randomized controlled trials[18,19] employed early mobilization, enhanced nutrition, sleep hygiene, early reduction of invasive procedures (eg, urinary catheterization), and pain control in their multicomponent models. Five additional studies also incorporated early mobilization,[20,22,23,31,32] and three sought to improve sleep quality.[22,28,30] Among other important strategies were delirium screening,[18,20,22,30,31] monitoring medication,[18,20,22,26,28,30,32] orientation,[18,21,23,28] addressing vision and hearing impairment,[18,22,23,32] hydration,[18,22,23] avoiding hypoxia,[18,20,30] and staff; Patient, and caretaker education.[19,21,23,27-30] Unique strategies were implemented in certain studies. For instance, one study used massage therapy,[28] preventing delays in transfer logistics in another,[30] and a third addressed psychosocial problems.[25] Overall, the selection of strategies depended on the patient setting; thus, no one care bundle should be expected to emerge as a universal model for delirium prevention. Rather, these results should be interpreted within their specific care contexts and judged on the quality of evidence (eg, effect size and statistically significant findings, low risk of bias, sound experimental design). The one study that failed to find any positive effect on delirium, that of Gagnon et al.,[21] was

conducted on an inpatient palliative care service in Canada, and its negative finding may reflect the unique delirium risk factors in patients who are nearing end of life.

This current review differs from previous delirium prevention reviews in operationally defining a "model of care." We identified a great deal of variation in specific models and team composition. For example, some interventions were carried out by nurses[18-20,31] and physicians,[20,21,25,32] whereas others involved physical therapists,[20,22,28] medical residents,[23] geriatricians,[22,23,25] pharmacists,[26] researchers,[18] and trained volunteers.[22] In all cases, the staff roles were expanded to include new tasks, and the clinical team worked collaboratively to administer interventions across multiple domains. Team-related considerations are critical because modern medical care is inherently interdependent.[9] These broad differences in team composition across studies demonstrate the number of potential options for team structure and function. They also highlight the number of "moving parts" to be considered when designing and implementing delirium care bundles.

Most of the delirium prevention studies implementing models of care are characterized by a substantial risk of bias. We evaluated risk of bias along six categories of potential sources, including random assignment to groups, ability to foresee future group allocation, blinding of participants and personnel to group assignment, blinding of outcome assessment, completeness of outcome data, selective reporting, and other potential sources of bias.[17] Two of the three studies that used randomization had a low risk of bias, and four additional studies had a moderate risk of bias. Allocation concealment was accomplished only in randomized controlled trials, whereas blinding of both subjects and study personnel was not implemented in any of the studies. Although some studies relied on data analysis by research personnel blinded to group membership or the nature of the intervention, others failed to do so or failed to describe data analysis in sufficient detail. Studies also failed to report the percentage of unscorable or otherwise omitted delirium assessments necessary to calculate attrition rates or to understand the comprehensiveness of outcome assessment in a systematic manner. Other potential sources of bias included systematic differences between the intervention and control groups (such as differences in gender composition, age, or delirium risk) at study outset.

A primary limitation of this review is the heterogeneity of settings, interventions, and models of care across included studies. We excluded several studies from this review for being delivered by a single individual or service line (eg, introduction of a geriatric consult service; Physical therapy, or volunteers), for providing a single intervention (eg, early ambulation alone), or for multiple interventions targeting a single domain (eg, sleep). We did so because the future of value-based care lies in collaboration of providers and services, and in a way the complexity across and within these studies ultimately reflects the complexity of medical settings as well as the multifactorial nature of delirium. The broader message is a call for increasing the integration of delirium-related care services. As discussed earlier, the high risk of bias across these studies is a limitation

of our findings; high-quality evidence on the value of delirium prevention models of care remains limited. Thus, although our review suggests that there are multicomponent models of care that hold promise in mitigating delirium and its outcomes, additional randomized studies are required to confirm the efficacy of such models of care and to test which services, interventions, and clinical domains deserve priority.

CONCLUSION

To our knowledge, this is the first systematic review and meta-analysis of delirium preventive models of care. Models of care, as defined here, necessarily included a multidisciplinary team in which traditional staff roles had been revised to implement a multicomponent, multidomain intervention. Other recent reviews are available for multicomponent pharmacological and nonpharmacological interventions to prevent and manage delirium,[41-49] but just as important as which interventions are being delivered is the team that delivers them. Care delivery in a complex medical system is more than handing a patient a medication or facilitating ambulation; it requires a choreographed dance of teamwork and integration across services. This review identifies promising models of care that deserve further recognition, refinement, and ultimately widespread implementation.

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