Translating Delirium Prevention Strategies for Elderly Adults with Hip Fracture into Routine Clinical Care: A Pragmatic Clinical Trial

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OBJECTIVES: To compare the feasibility (adherence) and effectiveness (prevalence of delirium, length of stay, mortality, discharge site) of delirium-friendly preprinted postoperative orders (PPOs) for individuals with hip fracture, administered by regular orthopedic nurses, with routine postoperative orders.

DESIGN: Pragmatic clinical trial to evaluate a quality improvement intervention.

SETTING: Tertiary care hospital.

PARTICIPANTS: Individuals aged 65 and older admitted for hip fracture repair (N = 283).

INTERVENTION: PPOs with delirium-friendly options and doses for nighttime sedation, analgesia, and nausea and attention to catheter removal and bowel movements.

MEASUREMENTS: Adherence to PPO was compared with adherence to routine orders. Drug doses were recorded. Presence of delirium was documented using the Confusion Assessment Method and the Mini-Mental State Examination on postoperative Days 1, 3, and 5. Length of stay, discharge site, and in-hospital mortality were recorded.

RESULTS: Orthopedic nurses adhered reasonably well with delirium-friendly PPOs. Of 283 participants, 42% developed postoperative delirium, with significantly less delirium in the intervention group (intervention 33%, control 51%, P = .001). The effect of the intervention was stronger in individuals with preexisting dementia (intervention 60%, control 97%, P < .001). Participants with postoperative delirium had longer hospital stays and were more likely to die or be discharged to a nursing home, but there was no significant between-group difference in these outcomes.

CONCLUSION: It is possible to introduce delirium-friendly PPOs into routine post-hip fracture care in a representative elderly population including individuals with dementia. Delirium-friendly PPOs executed by regular nursing staff resulted in a significant reduction in postoperative delirium but no difference in other outcomes. J Am Geriatr Soc 65:567–573, 2017.

Key words: delirium; hip fracture; knowledge translation; dementia

Delirium is common in elderly adults with hip fracture, occurring in 25% to 65%, and is associated with adverse outcomes, including functional decline and death. There is limited evidence of the effectiveness of treatment for established delirium but growing evidence of the efficacy of multifactorial interventions for delirium prevention. The strongest evidence is for nonpharmacological interventions, including educational interventions, and multicomponent interventions performed by research personnel or trained volunteers. Access to specialized orthogeriatric services is not routinely available. Multicomponent interventions target known delirium risk factors, including overuse of medications associated with delirium, but given organizational and resource constraints, translating multicomponent strategies and best practice guidelines into routine clinical care can be a challenge, and the benefits of educational interventions can wane with time and staffing turnover. Institution-wide implementation of strategies to reduce the use of risky drugs in elderly adults has been successful, whereas adoption of an electronic postoperative hip fracture clinical pathway as a form of clinical decision support showed variable success depending on engagement of frontline staff, underlying concerns with adherence. A before-and-after comparison after implementation of a

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multifactorial prevention program in individuals with hip fracture demonstrated a significant reduction in the incidence of postoperative delirium, although because individuals with any cognitive impairment, which is common in this population, were excluded, its generalizability is uncertain.\(^{17,18}\)

Delirium-friendly preprinted orders (PPOs) were created for elderly adults with hip fracture after surgery using the same format as PPOs already in use on orthopedic units. Interventions that lent themselves easily to the PPO format were included, including orders for nausea, nighttime sedation, pain control, and bowel and bladder care. Previous multifactorial intervention protocols\(^5,11\) have included attention to sensory impairment and targeted responses to individuals’ postoperative complications, oxygenation, fluid status, and nutritional needs; these interventions do not lend themselves easily to a standardized PPO and physicians rather than nursing staff generally administer them, together with medication reviews. In the interest of knowledge translation (and to encourage adherence), only delirium risk factors that could be included in a standardized PPO were addressed.

The primary objective of this quality improvement intervention study was to assess the feasibility of knowledge translation into routine clinical care using delirium-friendly PPOs, with comparison of adherence with usual care. To make the results more generalizable to a typical population with hip fracture, individuals with preexisting cognitive impairment were not excluded. The second objective was to investigate whether implementation of delirium-friendly PPOs, as executed by regular orthopedic ward nurses, could reduce the prevalence of postoperative delirium. Any effects on length of stay on the orthopedic unit and eventual discharge setting were also examined.

**METHODS**

**Study Design**

In a tertiary care teaching hospital, one orthopedic ward was assigned as control and one ward as intervention. Patients were admitted to one floor or the other from the emergency department based solely on bed availability. Admission to a given ward is by chance allocation, because all surgeons admit to all wards, occupancy is high, and all wards have similar numbers of beds, including private and semiprivate rooms. Under these circumstances, the central assumption of randomization (that allocation is by chance so that participants cannot influence it) is not violated. This study is thus a pragmatic (assignment based on bed availability), controlled, single-blind quality improvement study comparing delirium-friendly PPOs with usual care PPOs, with regular orthopedic floor nurses entirely administering the intervention. The Capital Health Research Ethics Board approved this study.

**Study Population**

Individuals aged 65 and older with an admitting diagnosis of hip fracture were invited to participate. Recruitment took place preoperatively. Consent was obtained from next of kin for individuals who were not capable of giving consent to participate because of cognitive impairment. Exclusion criteria were pathological fracture, involvement in motor vehicle accident or multiple trauma, previous ipsilateral hip surgery, inability to understand and converse in English, nonambulatory prefracture status, and severe acute comorbidity preoperatively (e.g., overwhelming infection, severe congestive heart failure). A sample size of 280 was determined to be adequate to achieve a power of 0.8 for a one-sided test with an alpha of .05. Based on previous research, an incidence of postoperative delirium of approximately 40% and a 30% reduction in delirium were estimated. Such a reduction is roughly equivalent to an effect size of 0.6 and should be measurable with a sample of 280 participants. This degree of improvement in delirium has been achieved in previous research.\(^{11}\)

**Intervention**

**Preprinted Orders**

Ward staff (control floor) or research personnel (intervention floor) placed PPOs in the chart, and the attending staff physicians signed them. The format of the delirium-friendly PPOs is the same as that of usual care orders. Which set of postoperative PPOs was used did not influence the surgical procedure in any way.

**Common Elements**

Usual and intervention PPOs include identical orders for postoperative antibiotics, hip X-rays, physiotherapy consultation, approach to hypoxia, and open-ended orders for intravenous fluid and anticoagulation, depending on physician preference.

**Experimental Group**

Intervention orders deviate from routine standing orders (control) in the following ways.

- Acetaminophen administration is scheduled (rather than as needed), and doses and frequency of as-needed opioid analgesics are lower.
- The option for nighttime sedation is trazodone. Benzodiazepines are not initiated or abruptly withdrawn.
- For nausea, domperidone was available in lieu of dimenhydrinate.
- Urinary catheters were removed on postoperative Day 2, followed by postvoid residual (PVR) assessment. This is left up to the discretion of nursing on control orders.
- Laxatives are scheduled, rather than regular softeners and as-needed laxatives on control orders.
- Postoperative blood work is expanded to include electrolytes, urea, and creatinine to help the treating team identify dehydration.
- In the event of severe agitation, low doses of haloperidol are specified on the PPO, in addition to the requirement to alert on-call physician.

**Procedure**

Research personnel completed risk factor screening with participants using the Delirium Elderly At Risk Scale\(^{19-21}\).
and cognitive screening using the Mini-Mental State Examination (MMSE)\textsuperscript{22} preoperatively. The MMSE was repeated on postoperative Days 1, 3, and 5. The Confusion Assessment Method (CAM)\textsuperscript{23} was used to identify delirium preoperatively and on postoperative Days 1, 3, and 5 using information from the participant encounter, the medical record, and nursing staff. It was not possible to blind research personnel to treatment group, because allocation was conducted according to floor.

**Assessments**

**Baseline Characteristics**

Age, sex, and delirium risk factors as recorded on the Delirium Elderly At Risk Scale (age, sensory impairment, need for assistance with one or more activities of daily living, preoperative MMSE score, regular ethanol or benzodiazepine use) were recorded preoperatively. Other baseline information collected included existing dementia diagnosis (by searching the medical record and interviewing family members), baseline mobility (independent with or without a walking aid or with assistance of another person before hip fracture), home setting (community independent, community with supports, assisted living, nursing home), and number of comorbidities (any coexisting medical condition). Wait time to surgery (according to calendar date) was recorded. Preoperative delirium was documented using the CAM.

**Adherence to PPO**

Medication records were reviewed to document adherence to postoperative antibiotic orders for both groups. Total postoperative dimenhydrinate (on control PPO) and domperidone (on intervention PPO) doses were recorded. Benzodiazepine use and nighttime sedation with nonbenzodiazepine hypnotics (zopiclone, chloral hydrate) or trazodone were documented from the medication records. Adherence to blood work orders was noted. Adherence to laxative orders was recorded, as well as number of days postoperatively until first bowel movement. Diarrhea within 5 days after surgery was documented from daily nursing flow sheets. Adherence to intervention orders to remove urinary catheters by postoperative Day 2 and to assessment of PVR volume within 12 hours of catheter removal was noted. Medication records were reviewed to determine whether acetaminophen was administered regularly. Amount of opioid consumed during postoperative Days 1 to 5 was calculated, and all opioid doses were converted to subcutaneous morphine equivalents using a standard opioid conversion table.\textsuperscript{24} 

**Outcomes**

Delirium was documented using the CAM, in conjunction with the MMSE and review of participant charts, on postoperative Days 1, 3, and 5. Amount of haloperidol used during the first 5 days postoperatively was recorded. Length of stay on the orthopedic unit was noted. Mortality at any point during hospital stay (including if moved to a rehabilitation unit from orthopedic ward) and eventual discharge site were recorded. Charts were reviewed to record the occurrence of eight postoperative complications (need for transfusion, infection requiring antibiotics, need for reoperation, falls, cardiac complications, gastrointestinal complications, thromboembolic complications, chronic obstructive lung disease exacerbations).

**Statistical Analysis**

All statistical analyses were performed using SAS version 9.3 (SAS Institute, Inc., Cary, NC). Baseline characteristics of the intervention and control groups were compared using chi-square analysis for categorical variables and t-tests for continuous variables. Nursing adherence was assessed by comparing adherence with orders for postoperative antibiotics and blood work on control and intervention PPOs using chi-square testing. Adherence to urinary catheter orders on the intervention PPO was documented and compared with that of controls using chi-square analysis. Adherence to prescribed laxatives was compared using chi-square analysis, as was documented diarrhea at any time on postoperative Days 1 to 5. Time to first bowel movement was analyzed using t-tests. Whether acetaminophen was administered on a regular schedule (rather than as needed) was compared between intervention and control participants using chi-square analysis, as was receipt of any benzodiazepine or nonbenzodiazepine sleeping pill and receipt of any postoperative haloperidol. T-tests were used to compare cumulative dosages on postoperative Days 1 to 5 of dimenhydrinate, domperidone, and morphine equivalents. Rates of postoperative delirium (postoperative Days 1, 3, and 5) and mortality (any time during index hospitalization) of participants receiving intervention and control PPOs were compared using chi-square analysis and controlling for preexisting diagnosis of dementia. Length of stay on the orthopedic unit (t-test) and ultimate discharge destination to nursing home (chi-square) of the groups were compared. The presence or absence of any postoperative complications in the groups was compared using chi-square analysis. Individual complications were not tested, because cell counts were too small to allow valid statistical testing.

**RESULTS**

Of 438 individuals screened, 283 agreed to participate (Appendix S1). One hundred fifty individuals were screened but not enrolled because they were taken to surgery before preoperative measures were made. This occurred for three main reasons: refusal to participate, significant cognitive impairment and difficulty reaching substitute decision-makers for consent, and individuals going to surgery before they could be assessed because of short wait times or weekend admission.

There were no differences in age, sex, sensory impairment, need for assistance with at least one activity of daily living, substance use, preoperative MMSE score, or comorbidities between the intervention and control groups (Table 1). There was no difference in wait time to surgery between the two groups. There were statistically more participants with dementia in the intervention group (n = 48, 33%) than the control group (n = 29, 21%) ($\chi^2 = 5.6$, ...
Delirium was common (57.6% overall), with no difference between groups (intervention 61%, control 54%; $\chi^2 = 1.48, P = .22$).

Adherence to prescribed postoperative antibiotics was nearly 100% for intervention and control nurses (intervention 98.6%, control 99.3%; $\chi^2 = 0.3, P = .58$). Adherence to orders for drawing postoperative blood work was marginally better in control participants (intervention 88%, control 95%; $\chi^2 = 4.9, P = .03$). Adherence to PPOs for postoperative laxatives was not different between groups (intervention 83%, control 88%; $\chi^2 = 1.18, P = .28$), but intervention orders resulted in a significantly earlier first postoperative bowel movement (intervention 2.4 days, control 3.3 days; $\chi^2 = 5.01, P < .001$) and a lower incidence of diarrhea (intervention 11%, control 22%; $\chi^2 = 6.47, P = .01$) (Table 2).

There were significantly more catheter removals on Day 2 in the intervention group (intervention 85%, control 46%; $\chi^2 = 46.9, P < .001$). Adherence to documentation of PVR volumes was poor in the intervention group (53%) although at a significantly higher rate than in control participants (18%; $\chi^2 = 35.6, P < .001$).

Orders pertaining to nausea differed between the intervention and control groups. This resulted in the use of significantly more domperidone on average in the intervention group (intervention 68 mg, control 4.5 mg; $t = 14.4, P < .001$) and significantly less dimenhydrinate (intervention 1.9 mg, control 14.8 mg; $t = 5.12, P < .001$).

For nighttime sedation, control orders allowed chloral hydrate, and intervention orders allowed trazodone, on an as needed basis. Benzodiazepines were not on either orders and were used in negligible quantities in either group. Intervention participants used slightly more trazodone (27 mg) than control participants (13.5 mg; $t = 1.85, P = .06$). Control participants were administered more zopiclone (not on PPO) than chloral hydrate, so these two hypnotics were analyzed together. Control participants were significantly more likely to receive at least one dose of chloral hydrate or zopiclone (25%) than intervention participants (13%; $\chi^2 = 6.58, P = .01$).

Acetaminophen was given on a regular basis significantly more often in intervention than control participants (intervention 81%, control 43%; $\chi^2 = 42.1, P < .001$). All opioids received on postoperative Days 1 to 5 were converted to subcutaneous morphine equivalents. Control participants received significantly more opioid analogs postoperatively (44 mg) than intervention participants (24 mg; $t = 3.34, P = .001$). Table 2 summarizes the differences achieved in patient management using the delirium-friendly intervention PPOs.

Forty-two percent of participants had postoperative delirium. Delirium was most prevalent on postoperative Day 1 (intervention 27%, control 42%) and least prevalent on postoperative Day 5 (intervention 7%, control 30%) (Appendix S2). Seventy-seven of the 283 (27%) participants had previously been diagnosed with dementia. Participants with dementia were significantly more likely to develop postoperative delirium (dementia 74%, no dementia 30%; $\chi^2 = 45.5, P < .001$). By chance, there were more participants with dementia in the intervention group than the control group. Despite that, intervention...

### Table 1. Baseline Characteristics of Intervention and Control Group Participants

| Characteristic                        | Intervention Group, n = 144 | Control Group, n = 139 | P-Value |
|---------------------------------------|-----------------------------|------------------------|---------|
| Age, mean ± SD                        | 83.2 ± 7                    | 82.5 ± 10              | .57     |
| Male, n (%)                           | 30 (21)                     | 40 (29)                | .12     |
| Sensory impairment, n (%)             | 75 (52)                     | 73 (53)                | .94     |
| Need of assistance with activity of daily living, n (%) | 48 (33) | 41 (30) | .49     |
| Regular substance use, n (%)         | 35 (24)                     | 35 (25)                | .86     |
| Preoperative Mini-Mental State Examination score, mean ± SD (30) | 7.3 ± 3 | 7.4 ± 3 | .79     |
| Number of comorbidities, mean ± SD   | 2.8 ± 1.8                   | 2.6 ± 1.7              | .33     |
| Dementia n (%)                        | 48 (33)                     | 29 (21)                | .02     |
| Preoperative delirium, n (%)         | 88 (61)                     | 75 (54)                | .22     |

Significance tested using Pearson chi-square test or Student t-test.

*Subcutaneous morphine equivalents.

### Table 2. Adherence to Postoperative Orders and Differences in Treatment Using Delirium-Friendly Intervention and Control Preprinted Orders

| Treatment            | Intervention Group, n = 144 | Control Group, n = 139 | P-Value |
|----------------------|-----------------------------|------------------------|---------|
| Adherence to orders for, % |                              |                        |         |
| Antibiotics          | 98.6                        | 99.3                   | .58, $\chi^2 = 0.3$ |
| Blood work           | 88                          | 95                     | .03, $\chi^2 = 4.9$ |
| Laxatives            | 83                          | 88                     | .28, $\chi^2 = 1.18$ |
| Difference in postoperative treatment |                  |                        |         |
| Days to first bowel movement | 2.4                      | 3.3                   | <.001, $\chi^2 = 5.01$ |
| Postoperative diarrhea, % |                        |                        |         |
| Catheter removal Day 2, % | 11                       | 22                    | .01, $\chi^2 = 6.47$ |
| Postvoid residual documentation, % | 53                        | 18                    | <.001, $\chi^2 = 35.6$ |
| Dimenhydrinate, mg/5 days | 1.9                      | 14.8                  | <.001, $t = 5.12$ |
| Trazodone, mg/5 days | 27                          | 13.5                   | .06, $t = 1.85$ |
| Any zopiclone or chloral hydrate, % | 13                        | 25                    | .01, $\chi^2 = 6.58$ |
| Regularly administered acetaminophen, % | 81                        | 43                    | <.001, $\chi^2 = 42.1$ |
| Opioids received, mg/5 days* | 24                        | 44                    | .001, $t = 3.34$ |
group participants were significantly less likely to have postoperative delirium (33%) than controls (51%) ($\chi^2 = 9.9$, $P = .001$). Controlling for dementia showed a significant effect of the intervention on preventing postoperative delirium in participants with and without dementia, with a stronger effect in participants with preexisting dementia (Table 3). Fourteen patients (5%) died during the index hospitalization, eight (57%) of whom had a diagnosis of dementia, and six (43%) did not; in comparison, only 25% of participants who survived had been diagnosed with dementia ($\chi^2 = 6.7$, $P = .009$). All but one participant who died had had postoperative delirium (93%, $P < .001$). There was no significant difference in mortality between the groups (intervention 2.8%, control 4.2%, $P = .36$). There was no difference in the occurrence of postoperative complications (intervention 50%, control 42%; $\chi^2 = 1.9$, $P = .16$). Haloperidol use was negligible in both groups, with no statistically significant difference. Participants who survived to hospital discharge were more likely to be discharged to a nursing home after an episode of postoperative delirium than those who did not have an episode of delirium (controlling for whether they came from a nursing home). There was no difference in likelihood of nursing home discharge between groups ($\chi^2 = 1.3$, $P = .25$).

## DISCUSSION

A population of frail elderly adults with hip fracture and considerable comorbidity, sensory impairment, and functional dependence was studied. Unlike most previous trials, individuals with preoperative cognitive impairment, dementia, and delirium were included, making this a more-representative hip fracture population.

This study demonstrated that it is possible to introduce delirium-friendly PPOs into routine clinical care, with reasonably good adherence of nursing staff. There were a few minor differences in adherence compared with routine care, for example, in completing postoperative blood work. It is likely that this is because nursing and clerical staff were so used to submitting the usual requisitions for drawing blood for individuals with hip fracture that they may have done so as part of the routine without double-checking. There did not appear to be a problem with medication orders; medications and doses would have been inscribed onto the nursing medication record and double-checked when medications were administered. Adherence to orders for catheter and bladder care was not perfect. Decisions about catheter removal and PVR measurement are left up to nursing discretion on the usual care PPO, and nurses may have had trouble relinquishing decision-making control or simply proceeded out of habit. Given that the PVR orders were followed only 53% of the time, it might be concluded that this was not an essential part of the delirium-friendly PPO package, but bladder catheters were promptly removed and earlier postoperative bowel movements were accomplished in a significant proportion of intervention participants.

There were several significant differences in postoperative medication use between the intervention and control groups, including less dimenhydrinate use in intervention participants and differences in hypnotic use. Benzodiazepine use was negligible in both groups, a testament to previous efforts at improving patient care.

Pain control is important in individuals with hip fracture after surgery because severe pain, in particular in cognitively intact individuals, and postoperative analgesia can contribute to postoperative delirium. Individuals with dementia may receive fewer opioids after hip fracture, probably because of their greater risk of developing delirium. The addition of regularly dosed acetaminophen has been shown to reduce postoperative opioid consumption and increase patient satisfaction, and the regular dosing may ensure more-constant analgesia in particular in cognitively impaired individuals who may not know to ask for as-needed medications. The delirium-friendly PPOs resulted in significantly greater use of regularly dosed acetaminophen and significantly lower use of opioid analgesics.

Intervention group participants were successfully treated using delirium-friendly PPOs and had a significantly lower rate of postoperative delirium. This study was not powered to determine which individual factors of the PPOs were more or less associated with the reduction in postoperative delirium, and previous studies have also shown multifactorial approaches to be the most effective. The highest prevalence of delirium was on postoperative Day 1, tapering off on Days 3 to 5; this might support the interpretation that the intervention had an effect, rather than unrelated postoperative complications explaining the difference.

Episodes of postoperative delirium were associated with longer stays and greater risk of death and nursing home placement. Although delirium-friendly PPOs resulted in less postoperative delirium, there was no significant effect on length of stay, mortality, or nursing home placement. This may be due to the power of the study or perhaps other factors, for example the availability of home supports or delays in transfers to other facilities, are of

### Table 3. Outcomes Associated with Delirium Friendly Intervention and Control Preprinted Orders, Including Delirium in Participants with and without Dementia

| Outcome                        | Intervention Group, n = 144 | Control Group, n = 139 | P-Value |
|--------------------------------|-----------------------------|------------------------|---------|
| Death, n (%)                   | 4 (2.8)                     | 10 (7.8)               | .09, $\chi^2 = 2.9$ |
| Length of stay on orthopedic unit, days | 14.5                         | 15.6                   | .36, $t = 0.92$ |
| Delirium, n (%)                |                             |                        |         |
| Whole group (n = 283)          | 47 (33)                     | 71 (51)                | .001, $\chi^2 = 9.9$ |
| Dementia (n = 77)              | 29 (60)                     | 28 (97)                | <.001, $\chi^2 = 12.3$ |
| No dementia (n = 206)          | 18 (19)                     | 43 (39)                | .001, $\chi^2 = 10.2$ |
equal or greater importance in determining these outcomes and diluted the effect of the intervention that might have expected based on the lower incidence of delirium. In addition, having a dementia diagnosis was significantly associated with death during index hospitalization, as well as with the risk of developing postoperative delirium. Individuals with preoperative dementia were not excluded in an effort to make the findings more widely applicable. There were, by chance, significantly more individuals with dementia in the intervention group. Delirium-friendly PPOs were found to be most successful in preventing postoperative delirium in individuals who had previously been diagnosed with dementia. Individuals with dementia are at greater risk of delirium and may thus benefit the most from alterations in postoperative orders that make medication doses and the overall approach to management more delirium friendly.

Participants were assigned by chance to intervention and control wards based on bed availability, which minimizes the risk of selection bias and contamination. Participants were unaware of the details of their treatment orders. Nevertheless, although the CAM is a standardized, validated tool with high interrater reliability and was applied in conjunction with observations from family and the healthcare team whenever available, it was not possible to blind research personnel; this is a limitation of the study because conscious or unconscious bias during assessment of delirium cannot be excluded. Another limitation is that participants’ perception of pain was not assessed, although nurses had the freedom to give additional medication as needed on both sets of PPOs. Participants were not stratified according to degree of frailty, which can affect outcomes.

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REFERENCES

1. Holroyd-Leduc JM, Abelseth GA, Khandwala F et al. A pragmatic study exploring the prevention of delirium among older hip fracture patients: Applying evidence to routine clinical practice using decision support. Implement Sci 2010;5:81–86.
2. Marcantonio ER. Postoperative delirium: A 76 year old woman with delirium following surgery. JAMA 2012;308:73–81.
3. Tabet N, Howard R. Non-pharmacologic interventions in the prevention of delirium. Age Ageing 2009;38:374–379.
4. American Geriatrics Society Expert Panel. Postoperative delirium in older adults: Best practice statement from the American Geriatrics Society. J Am Coll Surg 2015;220:136–148.
5. Abraha I, Trotta F, Rimland JM 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:e0123090.
6. Reston JT, Schoelles KM. In-hospital delirium prevention programs as a patients safety strategy. Ann Intern Med 2013;158:375–380.
7. Lundström M, Edlund A, Lundström G et al. Reorganization of nursing and medical care to reduce the incidence of postoperative delirium and improve rehabilitation outcome in elderly patients treated for femoral neck fractures. Scand J Caring Sci 1999;13:191–200.
8. Lundström M, Olofsson B, Stenvall M et al. Postoperative delirium in old patients with femoral neck fracture: A randomized intervention study. Aging Clin Exp Res 2007;19:178–186.
9. Tabet N, Hudson S, Sweeney V et al. An educational intervention can prevent delirium on acute medical wards. Age Ageing 2005;34:152–156.
10. Deschmidt M, Braes T, Flamaing J et al. Preventing delirium in older adults with recent hip fracture through multidisciplinary geriatric consultation. J Am Geriatr Soc 2012;60:733–739.
11. Marcantonio ER, Facker JM, Wright RJ et al. Reducing delirium after hip fracture: A randomized trial. J Am Geriatr Soc 2001;49:516–522.
12. Inouye SK, Bogardus ST, Charpentier PA et al. A multi component intervention to prevent delirium in hospitalized older patients. N Engl J Med 1999;340:669–676.
13. Inouye SK, Borgardus ST Jr, Baker DJ et al. The Hospital Elder Life Program: A model of care to prevent cognitive and functional decline in older hospitalized patients. J Am Geriatr Soc 2000;48:1697–1706.
14. Kristensen PK, Thillemann TM, Soballe K et al. Can improved quality of care explain the success of orthogeriatric units? A population-based cohort study. Age Ageing 2016;45:66–71.
15. Aw D, Sahota O. Orthogeriatrics moving forward. Age Ageing 2014;43:301–305.
16. Fosnight SM, Allen KR, Holder CM et al. A strategy to decrease the use of risky drugs in the elderly. Cleveland Clin J Med 2004;71:561–568.
17. Bjorkelund KB, Hommel A, Thorngren KG et al. Reducing delirium in elderly patients with hip fracture: A multi-fac torial intervention study. Acta Anaesthesiol Scand 2010;54:678–688.
18. Siddiqui N. Predicting delirium: Time to use delirium risk scores in routine practice? Age Ageing 2016;45:9–10.
19. Freter SH, Dunbar MJ, MacLeod H et al. Preventing post-operative delirium in elective orthopaedic patients: The Delirium Elderly At Risk (DEAR) instrument. Age Ageing 2005;34:169–184.
20. Freter SH, George J, Dunbar MJ et al. Prediction of delirium in fractured neck of femur as part of routine preoperative nursing care. Age Ageing 2005;34:387–409.
21. Freter SH, Dunbar MJ, Koller K et al. Risk of pre- and post-operative delirium and the Delirium Elderly At Risk (DEAR) tool in hip fracture patients. Can Geriatr J 2015;18:212–216.
22. Folstein MF, Folstein SE. ‘Mini-mental state’: A practical guide for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189–198.
23. Inouye SK, van Dyck CH, Alessi CA et al. Clarifying confusion: The Confusion Assessment Method. Ann Intern Med 1990;113:941–948.
24. Alberta Cancer Board. Alberta Hospice Palliative Care Resource Manual, 2nd Ed. Calgary, Alberta: Alberta Cancer Board, 2001.
25. Morrison RS, Magaziner J, Gilbert M et al. Relationship between pain and opioid analgesics on the development of delirium following hip fracture. J Gerontol A Biol Sci Med Sci 2003;58A:76–81.
26. Wang Y, Sands LP, Vaurio L et al. The effects of postoperative pain and its management on postoperative cognitive dysfunction. Am J Psychiatr Psychiatry 2007;15:50–59.
27. Fong HK, Sands LP, Leung JM. The role of postoperative analgesia in delirium and cognitive decline in elderly patients: A systematic review. Anaesth Analg 2006;102:1255–1266.
28. Sieber FE, Mears S, Lee H et al. Postoperative opioid consumption and its relationship to cognitive function in elderly hip fracture patients. J Am Geriatr Soc 2011;59:2256–2262.
29. Schug SA, Sidebotham DA, McGuinney M et al. Acetaminophen as an adjunct to morphine by patient-controlled analgesia in the management of acute postoperative pain. Anesth Analg 1998;87:368–372.
30. Krishnan M, Beck S, Havelock W et al. Predicting outcome after hip fracture: Using a frailty index to integrate comprehensive geriatric assessment results. Age Ageing 2014;43:122–126.
31. Wei LA, Fearing MA, Sternberg E et al. The Confusion Assessment Method (CAM): A systematic review of current usage. J Am Geriatr Soc 2008;56:823–830.

SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Participant flow diagram. Flow diagram of participant progress through enrollment, intervention allocation, follow-up, and data analysis phases of this pragmatic clinical trial

Appendix S2. Prevalence of Postoperative Delirium on Postoperative Days 1, 3, and 5 According to Intervention Group

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