Background and Purpose

Delirium is common after hip fracture. Previous work has shown that a simple delirium risk factor tool, the Delirium Elderly At Risk instrument (DEAR), has a high inter-rater reliability in this population. Little research has looked at the ability of risk factor screening tools to identify patients at high risk of pre-operative delirium. This study investigates the ability of the DEAR to identify patients at high risk of pre-operative delirium, as well as reporting its performance in a post-operative validation sample. Associations between delirium risk factors and pre-operative delirium are explored.

Methods

This prospective cohort study took place on an orthopedic in-patient service at a University-affiliated tertiary care hospital. Patients aged 65 and older who were admitted for surgical repair of hip fracture (N = 283) were assessed pre-operatively for 5 delirium risk factors (cognitive impairment, sensory impairment, functional dependence, substance use, age) using the DEAR. Patients were assessed for delirium using the Mini-Mental State Examination and the Confusion Assessment Method pre-operatively and on post-operative days 1, 3 and 5. Characteristics of patients who developed delirium were compared with the characteristics of those who did not.

Results

Delirium was present in 58% (95% CI = 52–63%) of patients pre-operatively and 42% (95% CI = 36–48%) post-operatively. Individually, sensory impairment ($\chi^2 = 21.7, p = .0001$), functional dependence ($\chi^2 = 24.1, p = .0001$), cognitive impairment ($\chi^2 = 55.5, p = .0001$) and substance use ($\chi^2 = 7.5, p = .007$) were significantly associated with pre-operative delirium, as was wait-time for surgery ($t = 3.1, p = .003$) and length of stay ($t = 2.8, p = .03$). In multivariate modeling, the strongest association with pre-operative delirium was cognitive impairment.

Conclusions

The DEAR, a simple, delirium risk factor screening tool, can be used to identify hip fracture patients at risk of both pre-operative and post-operative delirium, which may allow targeted implementation of delirium prevention strategies.

Key words: delirium, pre-operative, post-operative, hip fracture

INTRODUCTION

Delirium is a common problem in elderly orthopedic patients and is associated with adverse outcomes, including longer length of hospital stay, decline in function and cognition, increased risk of nursing home placement, and death.(1–4) Multifactorial interventions can help prevent post-operative delirium in orthopedic patients.(5–8) Identifying those patients at high risk of delirium might help target such interventions. Common predictors of delirium in medical(9–15) and post-operative(16–22) populations are well known. However, delirium is commonly present pre-operatively as well, and pre-operative delirium has also been shown to be associated with poorer outcomes after hip fracture repair.(23,24) Little research has looked at the ability of risk factor screening tools to identify patients at higher risk of pre-operative delirium.

Previous work has shown that a simple, delirium-prediction tool, the Delirium Elderly At Risk instrument (DEAR), can be incorporated into routine pre-operative orthopedic nursing care in elective(25) and hip fracture(26) patients, with a
high inter-rater reliability. Here, we investigate the ability of the DEAR to identify patients at high risk of pre-operative delirium, as well as reporting its performance in a cross-validation sample of post-operative hip fracture patients. The study was approved by the hospital research ethics board.

METHODS

Patients over the age of 65 years who were admitted to the orthopedic ward with an admitting diagnosis of hip fracture were invited to consent to participate in a delirium prevention trial (to be reported elsewhere). Exclusion criteria were non-operative management, pathological fracture, motor vehicle collision as cause of fracture, comorbid illness requiring intensive care, and inability to understand and converse in English. Pre-operatively, all consenting patients completed the Mini-Mental State Examination (MMSE), and were assessed for pre-operative delirium using the Confusion Assessment Method (CAM). Five delirium risk factors are operationalized on the Delirium Elderly At Risk (DEAR) scale: (i) cognitive impairment, defined as an MMSE score less than or equal to 23; (ii) sensory impairment, defined as requiring a hearing aid or complaining of very poor vision; (iii) functional dependence, defined as needing assistance with any basic activity of daily living (ADL); (iv) substance use, defined as more than three drinks per week or use of a benzodiazepine more than three times per week; and (v) age over 80. Potential scores on the DEAR range from 0 (no risk factors) to 5 (all risk factors present). Previous studies have shown a cut-off of 2 (elective arthroplasty patients) or 3 (hip fracture patients) to provide the best sensitivity and specificity for predicting post-operative delirium. The MMSE, CAM, and DEAR were administered by trained research personnel. Time of day of the assessments was not standardized. Patients were followed post-operatively for 5 days, as part of a larger study on delirium prevention, and assessed on post-op days 1, 3, and 5 for delirium using the CAM. Wait time to surgery was counted by calendar date from date of admission, not by 24-hour blocks.

Demographic and clinical characteristics of patients who developed delirium were compared with the characteristics of those who did not. Categorical data were compared using chi-square, and continuous data using t-test. Multiple logistic regression was performed to explore the association between delirium risk factors and pre-operative delirium. Data were analyzed using SAS statistical software, version 9.3 (SAS Institute Inc, Cary NC).

RESULTS

The study included 283 hip fracture patients. The mean age was 83 years (range 65–101 years), with 213 women (75%) participants. Baseline delirium risk factors as recorded by the DEAR were quite common (Table 1). Delirium likewise was common, with 118 patients meeting CAM criteria post-operatively (41.6%, 95% CI = 35.9–47.5%) and 163 patients (57.6%, 95% CI = 51.8–63.4%) having or developing delirium pre-operatively. Significantly more patients with delirium risk factors (sensory impairment, functional dependence, cognitive impairment, and substance use) developed delirium in the pre-operative period. Pre-operative delirium was also associated with wait time for surgery, as well as subsequent hospital length of stay.

The sensitivity, specificity, positive predictive value, and negative predictive value are similar to those previously reported with DEAR cut-offs of 2 and 3 (Table 2). Lowering the cut-off gives a higher sensitivity but lower specificity for predicting both pre-operative, as well as post-operative, delirium.

Multiple logistic regression was performed to explore the association between delirium risk factors and pre-operative delirium. The best fit model included variables: cognitive impairment, substance use, sensory impairment, and wait time for surgery (see Table 3). Neither age nor ADL impairment remained in the model after adjustment for other risk factors. The strongest association with pre-operative delirium, as seen with post-operative delirium, was pre-operative cognitive impairment.

DISCUSSION

Post-operative delirium was documented in 41.6% of 283 hip fracture patients, which is within the expected range for this frail population. The DEAR risk factor screening tool showed reasonable predictive value in this post-operative hip fracture cross-validation sample, similar to previous findings in hip fracture and elective arthroplasty patients. Given the high prevalence of delirium in the hip fracture patients, and as seen previously in this population, using a DEAR cut-off of 3 or more gives the best positive predictive value for identifying patients at increased risk of developing delirium post-operatively as well as pre-operatively.

DEAR risk factors were associated with pre-operative delirium. Although pre-operative delirium has also been associated with worse functional outcomes, most delirium risk factor studies have focused on predicting incident post-operative delirium to the exclusion of pre-operative delirium. One potential benefit of improving the ability to identify who is at risk of post-operative delirium is the possibility of implementing targeted prevention measures in high-risk patients. As suggested in the recent American Geriatrics Society Clinical Practice Guidelines, certain interventions—for example, avoidance of deliriogenic medications—should be implemented perioperatively and with both prevention and management in mind. The prevalence of pre-operative delirium was higher, at 57.6%, than post-operative delirium in this study. Backing up delirium risk factor identification, delirium recognition, and potentially preventative interventions to the pre-operative period might further benefit patient outcomes as pre-operative cognitive change is itself a risk factor for post-operative delirium.
As in post-operative delirium, the most strongly associated variable on regression analysis of CAM-positive pre-operative delirium was the presence of pre-operative cognitive impairment, underlining the value of routine pre-operative cognitive screening in elderly hip fracture patients. Both documented substance use (benzodiazepine or alcohol) and sensory impairment were significantly associated with pre-operative delirium, as well. Documenting these risk factors pre-operatively helps to identify high-risk patients, as well as potentially remediable factors. As previously seen in patients with dementia undergoing hip surgery, wait time between admission and surgery was significantly associated with the development of delirium. Longer wait times may have given greater opportunity for occurrence of deliriogenic precipitants (infections, medications), or perhaps surgeries for patients with delirium were postponed.

Limitations of the study include the absence of any documentation on severity or subtype of delirium. Time of day of assessments was not standardized, and post-operative assessments were only done on post-operative days 1, 3, and 5, leaving the possibility that delirium onset or resolution was missed on days when there was no assessment. We have data only on the presence or absence of delirium pre-operatively, not on the timing of onset (e.g., before admission to the ward versus while awaiting surgery), which might be important with respect to how far back delirium prevention and management
interventions should begin (e.g., in the ambulance, in the emergency department). Further research on the feasibility and effectiveness of delirium prevention interventions in patients identified as high risk post- or pre-operatively is needed.

CONCLUSION

Documenting delirium risk factors with the DEAR pre-operatively can help identify hip fracture patients at risk of both pre-operative and post-operative delirium.

ACKNOWLEDGEMENTS

This work was supported by the Nova Scotia Health Research Foundation [grant number D2006-46]; and the Capital Health Research Fund. The authors would also like to acknowledge Jane Storey for her tireless enthusiasm in preparing the manuscript for ethics approval and grant application.

CONFLICT OF INTEREST DISCLOSURES

The authors declare no conflicts of interest. The sponsors had no direct role in the design, methods, subject recruitment, data collections, analysis, or preparation of manuscript.

REFERENCES

1. Marcantonio ER, Flacker LM, Michaels M, et al. Delirium is independently associated with poor functional recovery after hip fracture. J Am Geriatr Soc. 2000;48(6):618–24.
2. Witlox J, Eurelings LS, de Jonghe JF, et al. Delirium in elderly patients and the risk of postdischarge mortality, institutionalization, and dementia: a meta-analysis. JAMA 2010;304(4):443–51.
3. Kat MC, de Jonghe JF, Vreeswijk R, et al. Mortality associated with delirium after hip surgery: a 2-year follow-up study. Age Ageing. 2011;40(3):312–18.
4. Morandi A, Davis D, Fick DM, et al. Delirium superimposed on dementia strongly predicts worse outcomes in older rehabilitation inpatients. J Am Med Dir Assoc. 2014;15(5):349–54.
5. Marcantonio ER, Flacker JM, Wright RJ, et al. Reducing delirium after hip fracture: a randomized trial. J Am Geriatr Soc. 2001;49(5):516–22.
6. Lundstrom M, Olofsson B, Stenvall M, et al. Postoperative delirium in old patients with femoral neck fractures: a randomized intervention study. Aging Clin Exp Res. 2007;19(3):178–86.
7. Vidán M, Serra JA, Moreno C, et al. Efficacy of a comprehensive geriatric intervention in older patients hospitalized for hip fracture: a randomized, controlled trial. J Am Geriatr Soc. 2005;53(9):1476–82.
8. Akunne A, Davis S, Westby M, et al. The cost-effectiveness on multi-component interventions to prevent delirium in older people undergoing surgical repair of hip fracture. Eur J Orthop Surg Traumatol. 2014;24(2):187–95.
9. Inouye SK, Viscoli CM, Horwitz RI, et al. A predictive model for delirium in hospitalized elderly medical patients based on admission characteristics. Ann Intern Med. 1993;119(6):474–81.
10. Carrasco MP, Villarroel L, Andrade M, et al. Development and validation of a delirium predictive score in older people. Age Ageing. 2013;42(1):1–6.
11. Eeles EM, White SV, O’Mahony SM, et al. The impact of frailty and delirium on mortality in older inpatients. Age Ageing. 2012;41(3):412–16.
12. Kobayashi D, Takahashi W, Arioka H, et al. A prediction rule for the development of delirium among patients in medical wards: chi-square automatic interaction detector (CHAID) decision tree analysis model. Am J Geriatr Psychiatry. 2013;21(10):957–62.
13. Martinez JA, Belastegui A, Basabe I, et al. Derivation and validation of a clinical prediction rule for delirium in patients admitted to a medical ward: an observational study. BMJ Open. 2012;2:e001599.
14. Douglas VC, Hessler CS, Dhaliwal G, et al. The AWOL tool: derivation and validation of a delirium prediction rule. J Hosp Med. 2013;8(9):493–99.
15. O’Keeffe E, Mukhtar O, O’Keeffe ST. Orientation to time as a guide to the presence and severity of cognitive impairment in older hospital patients. J Neurol Neurosurg Psychiatry. 2011;82:500–04.
16. Marcantonio ER, Goldman L, Mangione CM, et al. A clinical prediction rule for delirium after elective noncardiac surgery. JAMA. 1994;271(2):134–39.
17. Kalisvaart KJ, Vreeswijk R, de Jonghe JFM, et al. Risk factors and prediction of postoperative delirium in elderly hip-surgery patients: implementation and validation of a medical risk factor model. J Am Geriatr Soc. 2006;54(5):817–22.
18. Moerman S, Tuinebreijer WE, de Boo M, et al. Validation of the risk model for delirium in hip fracture patients. Gen Hosp Psychiatry. 2012;34(2):153–59.
19. Ansaloni L, Catena F, Chattat R, et al. Risk factors and incidence of postoperative delirium in elderly patients after elective and emergency surgery. Br J Surg. 2010;97(2):273–80.
20. Priner M, Jourdain M, Bouche G, et al. Usefulness of the short IQCODE for predicting postoperative delirium in elderly patients undergoing hip and knee replacement surgery. Gerontology. 2008;54(2):116–19.
21. Dasgupta M, Dumbrell AC. Preoperative risk factor assessment for delirium after noncardiac surgery: a systematic review. J Am Geriatr Soc. 2006;54(10):1578–89.
22. Lee HB, Mears SC, Rosenberg PB, et al. Predisposing factors for post-operative delirium after hip fracture repair among patients with and without dementia. J Am Geriatr Soc. 2011;59(12):2306–13.
23. Dolan MM, Hawkes WG, Zimmerman SI, et al. Delirium on hospital admission in aged hip fracture patients: prediction of mortality and 2-year outcomes. J Gerontol A Biol Sci Med Sci. 2000;55(9):M527–M534.
24. Gruber-Baldini AL, Zimmerman S, Morrison RS, et al. Cognitive impairment in hip fracture patients: timing of detection and longitudinal follow-up. J Am Geriatr Soc. 2003;51(9):1227–36.
25. Freter SH, Dunbar MJ, MacLeod H, et al. Predicting post-operative delirium in elective orthopaedic patients: the Delirium Elderly At Risk (DEAR) instrument. Age Ageing. 2005;34(2):169–84.
26. 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(4):387–88.
27. Folstein MF, Folstein SE, McHugh, PR. Mini-mental state: a practical guide for grading the cognitive state of patients for the clinician. J Psychiatr Res. 1975;12(3):189–98.
28. Inouye SK, van Dyck CH, Alessi CA, et al. Clarifying confusion: the Confusion Assessment Method. Ann Intern Med. 1990;113(12):941–48.
29. Holt R, Young J, Heseltine D. Effectiveness of multi-component intervention to reduce delirium incidence in elderly care wards. Age Ageing. 2013;42(6):721–27.
30. American Geriatrics Society Expert Panel on Postoperative Delirium in Older Adults. American Geriatrics Society abstracted clinical practice guideline for postoperative delirium in older adults. J Am Geriatr Soc. 2015;63(1):142–50.

Correspondence to: Susan Freter, MD, MSc, Room 1308, 5955 Veteran’s Memorial Lane, Halifax, NS B3H 2E1, Canada
E-mail: susan.freter@nshealth.ca