ORIGINAL RESEARCH

Risk of Pre- and Post-Operative Delirium and the Delirium Elderly At Risk (DEAR) Tool in Hip Fracture Patients

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ABSTRACT

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 inpatient 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

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high inter-rater reliability.[26] 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)[27] and were assessed for pre-operative delirium using the Confusion Assessment Method (CAM).[28] 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)[25] or 3 (hip fracture patients)[26] 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,[26] 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,[23,24] 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.[4,29] 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.[30] 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.

TABLE 1.
Baseline risk factors, wait time for surgery, and length of stay in patients with and without pre-operative delirium

Variable	*Pre-operative Delirium n=163*	*No Pre-operative Delirium n=120*	*p-value*
Gender (% female)	73%	78.3%	0.305 chi-square
Pre-op MMSE, Mean (SD)	18.3 (6.7)	26.2 (3.8)	$p<.001$ *t*-test
Age > 80 years (%)	73	65	0.148 chi-square
Sensory Impairment (%)	62	39.2	$p<.001$ chi-square
Dependence in at least 1 ADL (%)	41.7	17.5	$p<.001$ chi-square
Cognitive Impairment (%), MMSE < 23	80.4	19.2	$p<.001$ chi-square
Substance Use (%)	30.7	16.7	0.007 chi-square
Wait Time for Surgery (days), Mean (SD)	2.9 (2)	2.3 (1.3)	0.003 *t*-test
Length of Stay (days), Mean (SD)	16.2 (11.8)	13.4 (8.4)	0.03 *t*-test

TABLE 2.
Sensitivity, specificity, positive, and negative predictive value of the DEAR for pre-operative and post-operative delirium, using DEAR cut-off scores of 2 and 3

	Sensitivity (%)		*Specificity (%)*		*PPV*[a]		*NPV*[b]	
DEAR Cut-Off	2	3	2	3	2	3	2	3
Pre-operative Delirium	90.2	62.6	51	81.7	71.4	82.3	79.2	61.6
Post-operative Delirium	93.2	67.8	41.8	73.3	53.4	64.5	89.6	76.1

[a]Positive predictive value (%).
[b]Negative predictive value (%).

TABLE 3.
Analysis of maximum likelihood estimates, best fit model predicting pre-operative delirium

Parameter	*DF*	*Estimate*	*Standard Error*	*Wald Chi-square*	*P (chi square)*
Intercept	1	2.639	0.425	38.54	<.0001
Cognitive Impairment	1	-3.046	0.338	81.13	<.0001
Substance Use	1	-1.238	0.397	9.74	0.0018
Sensory Impairment	1	-0.929	0.328	8.05	0.0046
Wait Time to Surgery	1	-0.256	0.106	5.82	0.0159

As in post-operative delirium,[17,25,26] 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,[22] 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.

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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.

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