

# Research Letters

## Predicting post-operative delirium in elective orthopaedic patients: the Delirium Elderly At-Risk (DEAR) instrument

SIR—Delirium is a common problem in hospitalised older people, with prevalence estimates between 15% and 60% [1–3]. Estimates of delirium in elective orthopaedic patients tend to be in the 10–40% range [3–6]. As there is accumulating evidence for delirium prevention [1, 7–10], it is timely to identify elective orthopaedic patients who are at highest risk. Prospective trials have identified a number of risk factors for post-operative delirium (POD) in elective surgery patients, including older age, pre-existing cognitive impairment, sensory impairment, psychoactive medications, type of surgery, history of previous delirium and pre-operative functional impairment [3, 4, 11–15].

Delirium is associated with poor outcomes, at hospital discharge and several-month follow-up [2, 16, 17]. Delirium has been associated with longer length of hospital stay, nursing home placement, increased risk of death, and decline in function and cognition [16, 18]. It may be of benefit to have standardised pre-operative cognitive screening to identify patients at higher risk of acute confusion, and to facilitate post-operative diagnosis and management of cognitive decline. Using data collected prior to elective surgery, Marcantonio *et al.* [18] were able to stratify patients into risk groups for developing delirium. Risk factors included age, pre-operative cognitive and functional status, self-reported alcohol abuse and laboratory abnormalities [18]. This is similar to predictors identified on an acute geriatric unit [19]. Although clearly of value in predicting POD, information on baseline cognition and function is rarely systematically collected in usual practice. We endeavoured to translate existing information and test its feasibility when collected by nurses in the course of usual pre-operative care.

The diagnosis of delirium is commonly under-recognised by nurses and physicians [20–22]. The likelihood that nurses will detect delirium during routine care is lower in the presence of dementia and high baseline delirium risk [22]. Detection could be improved by documentation of baseline cognitive status, incorporating cognitive screening into routine clinical practice, education or clinical pathways [20, 23]. Identifying high-risk patients in the course of routine pre-operative care may allow for interventions designed to prevent or reduce the severity of POD.

Previous work supports collecting baseline information on risk factors to target patients for intervention. However, research protocols often employ personnel who are not available in the usual clinical setting [7]. We incorporated known predictors for POD [18] into routine pre-operative information gathering using the Delirium Elderly At-Risk instrument (DEAR). We assessed the feasibility of incorporating the

DEAR into routine nursing care of elective orthopaedic patients and evaluated its usefulness in predicting POD.

## Methods

### Setting and patients

Baseline data were collected routinely on patients over the age of 65, by nurses in the pre-operative arthroplasty clinic, and systematically recorded on five delirium risk factors on the DEAR (Appendix 1 available as supplementary data at the journal website: [www.ageing.oupjournals.org](http://www.ageing.oupjournals.org)). These five known risk factors were selected for their feasibility, as they use information that is readily available during routine pre-operative nursing assessment. Clinic nurses also performed cognitive screening using the Mini-Mental State Exam (MMSE) [24]. Nurses were instructed in performing the MMSE, by attending a 30-minute teaching session with a geriatrician. Validity and reliability of the MMSE have been shown in many studies [25]. Although abnormal laboratory values have been associated with the development of delirium [18, 19, 26], this information is not routinely interpreted by clinic nurses and may not be available at the time that the DEAR is recorded. This study was approved by the research ethics board.

Orthopaedic surgery was elective arthroplasty of the hip or knee, performed between 1 day and 4 weeks after pre-operative assessment. Prior to discharge from the orthopaedic service, delirium was diagnosed (by H.M. and S.F.) based on criteria from the Confusion Assessment Method (CAM), which is sensitive, specific, reliable and valid for identification of delirium [27]. The four CAM criteria are: (1) acute onset of confusion and fluctuating course; (2) inattention; (3) disorganised thinking; and (4) altered level of consciousness. Information with respect to delirium was compiled (by H.M.) from discussions with the charge nurse, attendance at team rounds, nursing notes and the medical record, and discussed with a geriatrician (S.F.) if necessary. Patients were seen daily on weekdays.

### Analysis

Descriptive statistics are reported. Factors related to incidence of delirium were compared using the chi-square test or *t*-test. The sensitivity and specificity of the DEAR in predicting delirium were calculated and receiver operating characteristic (ROC) analyses were performed. Logistic regression was performed with delirium as the dependent variable. Odds ratios and 95% confidence intervals (CI) are reported.

## Results

Baseline characteristics and information on POD were collected on 132 elective arthroplasty patients (Table 1). The mean age was 76.8 years ( $\pm 8$ ). Mean pre-operative

**Table 1.** Baseline risk factors and length of stay for POD

Baseline variable	Delirium (n=18)	No delirium (n=114)
Gender (% female)	65%	67%
Pre-op MMSE (max 30) <sup>a</sup>	28 (2.8)	25.5 (4.8)
Mean (SD)		
Risk factors (% patients with risk factor)		
Age ≥80 years	44%	50% NS
Sensory impairment	70.2%	83.3% NS
Dependence in ≥1 ADL	13.2%	22.2% NS
Cognitive impairment <sup>a</sup>	8.4%	61.1% $\chi^2=15.4, P<0.0001$
Substance use	29.8%	66.7% $\chi^2=9.3, P=0.0023$
Length of stay (days)	6.7	9.3 $t=2.18, P=0.031$

<sup>a</sup>Analysis excluded two patients owing to missing data.

**Table 2.** Multiple logistic regression analysis of DEAR risk factors for POD

Variable	Crude OR (CI)	Adjusted OR (CI)
Cognitive impairment <sup>a</sup>	6.96 (2.41, 20.07)	8.26 (2.44, 27.99)
Substance use	4.71 (1.63, 13.57)	6.98 (1.98, 24.66)
Age ≥80 years	1.28 (0.47, 3.46)	2.67 (0.72, 9.91)
Dependence in ≥1 ADL	1.89 (0.55, 6.50)	1.83 (0.40, 8.31)
Sensory impairment	2.13 (0.58, 7.82)	0.86 (0.18, 4.02)

<sup>a</sup>The -2 log likelihood improved from 92 to 80 with the additional variables.

MMSE score was 27.7 (±3.2). The MMSE was not completed pre-operatively on two patients, but information on other delirium risk factors was recorded. No patient refused to participate.

POD occurred in 18 patients (incidence 13.6%). Among elective arthroplasty patients, having two or more risk factors was associated with an eight-fold increase in the incidence of delirium (chi-square=6.33,  $P=0.01$ ) and with an increased length of stay (9.3 days versus 6.7 days;  $t=2.18, P=0.031$ ). ROC analysis gave an area under the curve (AUC) of 0.77 (95% CI=0.64–0.87) for the DEAR in predicting delirium. The pre-selected cut-off of two or more risk factors had a sensitivity of 0.61 and a specificity of 0.76. The corresponding positive likelihood ratio was 2.58 and the negative likelihood ratio was 0.51.

Logistic regression was used to explore the association between pre-operative factors and POD. In the univariate analysis, factors associated with the development of POD included substance use (OR=4.71, 95% CI=1.63–13.57) and cognitive impairment (OR=6.96, 95% CI=2.41–20.07). Both substance use (OR=9.98, 95% CI=1.96–24.66) and cognitive impairment (OR=8.26, 95% CI=2.44–27.99) remained predictive of delirium with adjustment for other baseline factors (see Table 2).

## Discussion

We studied 132 elective arthroplasty patients to identify risks for delirium. The delirium rate in this study, 13.6%, was within the expected range [3–6]. Nurses were able to incorporate systematic risk factor recording and cognitive

screening into pre-operative care throughout the study period, and have continued this practice as routine thereafter. The DEAR, which relies on baseline information on known delirium risk factors, can be used to identify individuals who are at greatest risk of POD. A score of two or more on the assessment instrument was associated with a greatly increased risk of delirium.

Our data must be interpreted with caution. Given the relatively small number of events, logistic regression analysis may be relatively unreliable. However, the factors in the final model are consistent with well-recognised important predictors. We did not attempt to measure delirium severity. Identifying patients who fall anywhere on the spectrum of delirium severity may be valuable for managing post-operative care. Our primary intent was to apply existing information to routine clinical care.

Cognitive impairment before surgery appears to be an important predictor of POD, and should be routinely screened. Pre-operative cognitive impairment, as measured by the MMSE [3, 4, 11, 18] or the Clock-Drawing Test [13], has been found to be an important predictor for POD.

Given the poor outcomes associated with delirium [16, 17, 28], it has been suggested that assessment of risk for delirium should be incorporated into pre-operative evaluation [3–6, 7, 29]. Nurses have a key role in early recognition of delirium, yet without standardised risk factor screening and cognitive assessment have demonstrated a low sensitivity for the detection of delirium [22]. Despite this, chart documentation of symptoms of delirium by nurses has been found to be fairly sensitive [30], suggesting that nurses take note of changes in the condition of delirious patients but may not always make the correct interpretation.

Part of the special challenge in delirium is not only that we do not know what best to do, but also that, quite commonly, we do not do those things which we know we ought to do, and we do too much of what we know we ought not to do. In consequence, the translation of existing information into better routine care is an important practical challenge, and one that largely has not been met. Our study shows that this can be done. POD is an important problem, and readily available baseline risk factors can be used to identify patients at increased risk of acute confusion and longer lengths of stay on an orthopaedic unit. It is possible to incorporate the systematic documentation of POD risk factors, using the DEAR, into routine pre-operative orthopaedic nursing care. Pre-operative cognitive screening by MMSE is particularly valuable for targeting patients at increased risk of post-operative confusion, and provides a useful baseline when evaluating POD. The nursing staff is in the best position to perform routine cognitive screening on admission to orthopaedics, and this task can be incorporated into usual nursing care.

Further research is required to evaluate the DEAR in other orthopaedic populations (e.g. hip fractures), and to design and implement delirium prevention interventions targeted at orthopaedic patients who are at increased risk of POD.

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**Key points**

- Delirium is common in post-operative orthopaedic patients.
  - Patients at high risk of developing POD can be identified using risk factor data available pre-operatively.
  - Systematic collection of baseline delirium risk factors can be accomplished by using the DEAR instrument, and can be incorporated into routine pre-operative nursing care.
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SUSAN H. FRETER<sup>1\*</sup>, MICHAEL J. DUNBAR<sup>2</sup>, HEATHER MACLEOD<sup>3</sup>,  
MICHELLE MORRISON<sup>4</sup>, CHRIS MACKNIGHT<sup>1</sup>,  
KENNETH ROCKWOOD<sup>1</sup>

<sup>1</sup>Dalhousie University, Department of Medicine, Division of Geriatric Medicine, Halifax, Nova Scotia, Canada

Fax: (+1) 902 473 7133

Email: susan.freter@cdha.nshealth.ca

<sup>2</sup>Dalhousie University, Department of Surgery, Division of Orthopaedics, Halifax, Nova Scotia, Canada

<sup>3</sup>Capital District Health Authority, Department of Occupational Therapy and

<sup>4</sup>Nursing, Halifax, Nova Scotia, Canada

\*To whom correspondence should be addressed

- Cole MG, Primeau F, McCusker J. Effectiveness of interventions to prevent delirium in hospitalized patients: a systematic review. *Can Med Assoc J* 1996; 155: 1263–8.
- Edlund A, Lundström M, Lundström G, Hedqvist B, Gustafson Y. Clinical profile of delirium in patients treated for femoral neck fractures. *Dement Geriatr Cogn Disord* 1999; 10: 325–9.
- Galanakis P, Bickel H, Grading R, Von Gumpfenberg S, Förstl H. Acute confusional state in the elderly following hip surgery: incidence risk factors and complications. *Int J Geriatr Psychiatry* 2001; 16: 349–55.
- Dupplis GS, Wikblad K. Acute confusional states in patients undergoing hip surgery. *Gerontology* 2000; 46: 36–43.
- Litaker D, Locala J, Franco K, Bronson DL, Tannous Z. Pre-operative risk factors for postoperative delirium. *Gen Hosp Psychiatr* 2001; 23: 84–9.
- Williams-Russo P, Urquhart BL, Sharrock NE, Charlson ME. Post operative delirium: predictors and prognosis in elderly orthopedic patients. *J Am Geriatr Soc* 1992; 40: 759–67.
- Inouye SK, Bogardus ST, Charpentier PA *et al.* A multicomponent intervention to prevent delirium in hospitalized older patients. *N Engl J Med* 1999; 340: 669–76.
- Milisen K, Foreman MD, Abraham IL *et al.* A nurse-led interdisciplinary intervention program for delirium in elderly hip-fracture patients. *J Am Geriatr Soc* 2001; 49: 523–32.
- Marcantonio ER, Flacker JM, Wright J, Resnick NM. Reducing delirium after hip fracture: a randomized trial. *J Am Geriatr Soc* 2001; 49: 516–22.
- Gustafson Y, Brännström B, Berggren D *et al.* A geriatric-anesthesiologic program to reduce acute confusional states in elderly patients treated for femoral neck fractures. *J Am Geriatr Soc* 1991; 39: 655–62.
- Edlund A, Lundström R, Brännström B, Bucht G, Gustafson Y. Delirium before and after operation for femoral neck fracture. *J Am Geriatr Soc* 2001; 49: 1335–40.
- MacDonald JB, Dutton MJ, Stott DJ, Hamblen DL. Evaluation of pre-admission screening of elderly patients accepted for major joint replacement. *Health Bull* 1992; 50: 54–60.
- Fisher BW, Flowerdew G. A simple model for predicting postoperative delirium in older patients undergoing elective orthopedic surgery. *J Am Geriatr Soc* 1995; 43: 175–8.
- Brauer C, Morrison S, Silberzweig SB, Siu AL. The cause of delirium in patients with hip fracture. *Arch Intern Med* 2000; 160: 1856–60.
- Dai YT, Lou MF, Yip PK, Huang GS. Risk factors and incidence of postoperative delirium in elderly Chinese patients. *Gerontology* 2000; 46: 28–35.
- Inouye SK, Rushing JT, Foreman MD, Palmer RM, Pompei P. Does delirium contribute to poor hospital outcomes? *J Gen Intern Med* 1998; 13: 234–242.
- Rockwood K. The occurrence and duration of symptoms in elderly patients with delirium. *J Gerontol Med Sci* 1993; 48: M162–6.
- Marcantonio ER, Goldman L, Mangione CM *et al.* A clinical prediction rule for delirium after elective noncardiac surgery. *JAMA* 1994; 271: 134–9.
- O’Keeffe ST, Lavan JN. Predicting delirium in elderly patients: development and validation of a risk-stratification model. *Age Ageing* 1996; 25: 317–21.
- Rockwood K, Cosway S, Stolee P *et al.* Increasing the recognition of delirium in elderly patients. *J Am Geriatr Soc* 1994; 42: 252–6.
- Gustafson Y, Brännström B, Norberg A, Bucht G, Winblad B. Underdiagnosis and poor documentation of acute confusional states in elderly hip fracture patients. *J Am Geriatr Soc* 1991; 39: 760–5.
- Inouye SK, Foreman MD, Mion LC, Katz KH, Cooney LM. Nurses’ recognition of delirium and its symptoms. *Arch Intern Med* 2001; 161: 2467–73.
- Inouye SK, Schlesinger MJ, Lydon TJ. Delirium: a symptom of how hospital care is failing older persons and a window to improve quality of hospital care. *Am J Med* 1999; 106: 565–73.
- 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: 189–98.
- Tombaugh TN, McIntyre NJ. The mini-mental state examination: a comprehensive review. *J Am Geriatr Soc* 1992; 40: 922–35.
- Inouye SK, Viscoli CM, Horwitz RI, Hurst LD, Tinetti ME. A predictive model for delirium in hospitalized elderly medical patients based on admission characteristics. *Ann Intern Med* 1993; 119: 474–81.
- Inouye SK, van Dyck CH, Alessi CA *et al.* Clarifying confusion: the Confusion Assessment Method. *Ann Intern Med* 1990; 113: 941–8.
- O’Keeffe S, Lavan J. The prognostic significance of delirium in older hospitalized patients. *J Am Geriatr Soc* 1997; 45: 174–8.
- Andersson EM, Gustafson L, Hallberg IR. Acute confusional state in elderly orthopaedic patients: factors of importance for detection in nursing care. *Int J Geriatr Psychiatry* 2001; 16: 7–17.
- Rolfson DB, McElhaney JE, Jhangri GS, Rockwood K. Validity of the Confusion Assessment Method in detecting postoperative delirium in the elderly. *Int Psychogeriatr* 1999; 11: 431–8.

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