A Simple Model for Predicting Postoperative Delirium in Older Patients Undergoing Elective Orthopedic Surgery.

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OBJECTIVE: To determine the incidence, and severity of postoperative delirium (POD) in older patients undergoing elective orthopedic procedures and to identify potential preoperative risk factors.

DESIGN: A prospectively studied cohort of elective orthopedic surgery patients.

SETTING: A University teaching hospital.

PATIENTS: Eighty patients who attended a preadmission clinic and, subsequently, underwent elective orthopedic surgery. All patients were aged 60 years or older, and all spoke English.

MEASUREMENTS: Patients underwent preoperative medical, cognitive, and activities of daily living assessment with standardized instruments and were followed postoperatively with daily visits, telephone interviews with attending nurses using a modified confusion assessment model (CAM), and repeated cognitive testing. Suspected delirium was verified by direct physician assessment.

RESULTS: The elective group had 14 (17.5%) cases of POD, of which six (7.5%) were severe. These incidences are low compared with those of nonelective surgery groups reported elsewhere in the literature. Stepwise multiple logistic regression identified two POD risk factors: clock-drawing scores ≤ 6 (OR = 9.0, CI, 2.8 to 45.6) and male gender (OR = 5.6, CI 1.9 to 33.8).

CONCLUSION: A simple model using clock-drawing scores and male gender for preoperative identification of elective patients at greatest risk for POD appears sensitive, predictive, and practical for the preadmission clinic setting, but it should be validated in a prospective trial. **J Am Geriatr Soc 43:175–178, 1995.**

Delirium is defined as a transient organic mental syndrome characterized by a global disorder of attention and cognition, reduced level of consciousness, abnormal levels of psychomotor activity, and disturbed sleep wake cycles. It is a common complication of surgery in older patients, with a greater reported incidence in orthopedic than in general surgery (44–55% vs 10–14%). The negative impact of delirium on postoperative outcomes,[1–6] recent improvements in methods for its detection,[7] and the demonstrated efficacy of early treatment[2,8,9] justify vigorous preoperative attempts to identify the patients at greatest risk so that limited nursing and physician resources may be directed toward those most likely to benefit.

Some studies utilizing postoperative orthopedic patients have attempted to identify risk factors for postoperative delirium (POD) in the elderly. Identified factors include male gender,[10–12] increasing age,[2,10–14] cognitive impairment,[11,12,14] physical impairments,[14] alcohol abuse,[14] anticholinergic medications,[1,4] and type of surgery.[14] However, these factors are inconsistently identified and appear in varying combinations in different studies. The reasons for this may be related to the diverse methods used to detect delirium or the proposed risk factors such as cognitive impairment; or they may be related to the limitations of statistical analysis in studies with smaller samples sizes. It is also possible that these differences reflect the different preoperative medical, functional, and cognitive profiles of the various patient populations studied. For example, risk assessment models for elective surgery patients may be different from those of patients undergoing nonelective surgery.

Predictive risk models exist for groups of medical, mixed medical surgical, and elective noncardiac surgical patients.[12,14,15] Presently, there are no such models derived purely from elective orthopedic patient populations. In addition, previous orthopedic studies have been restricted to older persons undergoing nonelective fracture repair or bilateral knee replacement. It is not certain that results from such nonelective studies are generalizable to the elective setting.

The objectives of this study were to determine the incidence, severity, and potential preoperative risk factors for POD in an older elective orthopedic surgery population. There are several reasons for studying such a patient population. Elective orthopedic surgery is commonly performed in older persons. The elective nature allows for more thorough and accurate determination of potential risk factors through preoperative assessment of medical, mental, and functional status, more standardized presentation and delivery of surgery, anesthesia, postoperative nursing care, and surveil-

lance, and the avoidance of the confounding effects of fracture-related pain, stress, and analgesia. Finally, elective procedures and preoperative management have the greatest potential for benefit from risk assessment information by allowing more directed, timely, and economical use of preventative measures, surveillance, and treatment.

METHODS

Approval was obtained from the University of Alberta Research Ethics Board before initiation of the study. Between September 1, 1992, and June 20, 1993, all patients attending a university teaching hospital orthopedics preadmission clinic for medical assessment before elective hip or knee replacement surgery were approached to obtain consent for inclusion in the study.

Exclusion criteria included refusal, previous enrollment in the study, age less than 60, and inability to speak English. Enrolled patients underwent same-day screening, which included history taking and physical examinations (incorporating functional disability screening recommendations of the American College of Physicians' Subcommittee on Aging[16]), as well as blood work, chest X-rays and EKG tracings, Folstein's Mini-Mental Status examination (MMSE), a clock-drawing test, and ADL and IADL scores (activities and instrumental activities of daily living). All histories and physical examinations were performed by the principal investigator. All ADL/IADL, MMSE, and clock-drawing assessments were administered by the same trained assistant. The principal investigator was blinded to these results until after patients had been discharged from the hospital. Clock-drawing results were scored independently by the principal investigator and a geriatrician, using a system modified from Sunderland et al.[17] and Wolfe-Klein et al.[18] and outlined in Table 1. In the four instances of discordance between the scores for a given clock, the higher score was accepted. A score of 6 or less was considered abnormal. For the purposes of this study, medical problems were considered significant if they represented important considerations in the assessment of general preoperative risk, were associated with potentially significant perioperative morbidity, or required special or ongoing perioperative management (e.g., diabetes, chronic obstructive lung disease, or stable angina), or if resolution before surgery was indicated. Some surgeries were postponed until such problems were rectified but there were no dropouts from the study for this reason.

Patients were followed from 8 hours postoperatively until the end of the fourth postoperative day. Surveillance was performed by the principal investigator and included daily visits and twice daily (6:30 AM and 10:30 PM) end-of-shift telephone interviews with attending nurses, using a modified confusion assessment model (CAM) questionnaire.[7] Attending nurses answered the CAM questionnaire on the basis of their personal observation of the patient during the preceding shift. They had had no prior training in the use of the CAM. MMSE and clock-drawing tests were repeated on the first and fourth postoperative days. In the event that the telephone interview CAM criteria were fulfilled, the principal investigator performed a history and physical examination, repeat CAM assessment, MMSE, and pertinent laboratory investigations as quickly as possible. In all cases, an attempt to determine the cause(s) of the POD was made, and recommendations for treatment or intervention were provided. POD was considered to have occurred if CAM criteria were

Table 1. Clock-Drawing Administration and Scoring System*

On a predrawn 8-cm circle, patients are requested to place all the numbers and the large and small hands in order to produce a clock face that reads "ten minutes after three o'clock." These same instructions are repeated as often as requested, but no other directions or instructions are given. No attempts are made to cover up any time pieces in the room.

A score of 6 or less constitutes an abnormally drawn clock.

Scoring:
10 Hands and numbers are all present and in the correct positions. Corrections without prompting are accepted as normal.
9 There are slight errors in placement of hands or 1 missing number without spacing errors.
8 There are moderate errors in placement of hands, confusion as to small and large hands, or spacing errors alone.
7 The placement of hands is significantly off course or spacing is inappropriate.
6 Clock hands are used inappropriately or there is use of digital display, circling of numbers, or perseveration in the writing of numbers.
5 Numbers are crowded to one end of the clock, reversed in order, or absent.
4 There is further distortion of the number sequence, counterclockwise order, many missing numbers, or numbers placed outside of the clock face border.
3 The numbers and clock face are no longer connected in the drawing.
2 Only vague representation of a clock or irrelevant spatial representation exist.
1 The result is uninterpretable or no attempt is made.

*Adapted from Sunderland et al.[17] and Wolfe-Klein et al.[18]

met, either through the telephone interview or the principal investigator's bedside assessment; it was thought to be severe if it lasted 5 or more days, if it caused severe caring problems such as pulling out intravenous lines or Foley catheters, climbing over siderails or violent or aggressive behavior, or if it required nursing or physician intervention. After patients were discharged, charts were reviewed and information collated on type and duration of anesthesia and intraoperative and postoperative problems.

Patients were classified into two groups based on the presence or absence of POD. Statistical analysis comparing the two groups was performed using t tests (for continuous variables) or Fisher's exact test (for discrete variables). Variables found to have P values less than 0.1 in this analysis were selected for stepwise multivariate logistic regression analysis to determine the best fit to a logistic model. The Statistica Analysis System (SAS) software package was used to perform all calculations and analyses.

RESULTS

Of 91 patients approached, 80 (88.3%) gave their consent and completed the study. The study population was 96.3% white and 3.7% Asian. Fifty-four percent were male, the mean age was 71.2 years, and the mean number

significant preoperative medical problems was 2.77. All patients were living independently at home before assessment. Fourteen patients (17.5%) met the CAM criteria for POD, and six (7.5%) were seriously delirious. The nurses' telephone CAM interview had high sensitivity relative to the principal investigator's final assessment of the patient, detecting 13 (92.8%) of the 14 cases of POD ultimately diagnosed.

The analysis of potential risk factors for POD is summarized in Table 2. Abnormal preoperative clock-drawing scores and male gender were the only two factors significantly associated with increased risk of POD when examined separately and also in combination using stepwise logistic regression.

No statistically significant relationships were found between POD and the following variables: age, education, first language other than English, ADL and IADL scores, number of preoperative medical problems, history of cerebrovascular accidents, number of medications used preoperatively, number of previous surgeries, history of alcoholism or CAGE score, history of depression, getting lost, prior POD, frequent falls, nocturnal confusion, urinary or fecal incontinence, hearing or visual acuity deficits, mobility scores, preoperative Mini-mental status examination scores, or hip versus knee surgery.

CONCLUSIONS

The modified CAM telephone interview system appeared to be a practical and sensitive method for surveillance of POD. The incidence and severity of detected POD in this elective population were significantly less than that of non-elective orthopedic surgery groups reported elsewhere in the literature (41–61.3% for total cases, 6.8–29.7% for severe cases).[10,11,13,14] The lower incidence of POD in this elective group may reflect inclusion into the preadmission and perioperative setting of factors that are both cited in Gustafson's intervention study[11] and commonly employed in preadmission and elective patient management. These include preoperative assessment and correction of medical disorders, thromboembolic prophylaxis, postoperative oxygen therapy, and control of postoperative immobility and pain. In addition, the incidence of severe confusion in this elective group is comparable to Gustafson's intervention group (7.5% vs 6.8%) and may represent the effect of earlier and more

effective detection of less severe cases of POD, thus preventing their progression in severity.

Patients who experienced POD were significantly more likely to have been male and to have had abnormal scores (≤6) on the clock test. In this study, abnormal clock-drawing test scores were significantly associated with the development of POD, but abnormal MMSE scores were not, even when construction and attention portions of the MMSE (intersecting pentagons and serial sevens) were separately analyzed. In the detection of dementia, the MMSE and clock-drawing tests appear to be of comparable sensitivity and specificity.[19] However, the clock test likely reflects visuospatial functioning more thoroughly than does the more verbally based MMSE.[17] The nondominant parietal lobe is not only associated with visuospatial function, but also appears to have an important role in high-order integration of sensory information and maintenance of attention, functions that are impaired in delirium.[20,21] Therefore, by measuring nondominant parietal function, the clock test may be indirectly detecting increased predisposition to the development of delirium.

In conclusion, abnormal clock-drawing scores and male gender are important predictors for increased risk of POD in patients undergoing elective hip or knee replacement surgery. Although this model should be tested by a prospective validation trial, it appears to provide a simple and clinically practical means of preoperative screening for "high risk" patients, allowing in turn for more efficient, timely, and directed interventions aimed at reducing the incidence and severity of POD.

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Table 2. Proportion of Patients with Postoperative Delirium (POD) and Associated Odds Ratios

Patient Profile	Proportion with POD	Odds Ratio (95% Confidence Intervals)
Female	3/43 (7.0%)	1.0
Male	11/37 (29.7%)	5.6 (1.9–33.8)
Clock Score >6	8/68 (11.8%)	1.0
Clock Score ≤6	6/11 (54.6%)	9.0 (2.8–45.6)
Female, Clock Score >6	2/37 (5.4%)	1.0
Female, Clock Score ≤6	1/5 (20.0%)	4.4 (0.8–98.5)
Male, Clock Score >6	6/31 (19.4%)	1.0
Male, Clock Score ≤6	5/6 (83.3%)	20.8 (4.1–1033)
All Patients	14/80 (17.5%)	

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