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ORIGINAL ARTICLE

Postoperative Delirium in Elderly Patients After Elective Hip or Knee Arthroplasty Performed Under Regional Anesthesia

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Abstract Delirium is a major adverse postoperative event in elderly patients. Incidence rates of postoperative delirium are difficult to determine. Because of the accuracy, brevity, and ease of use by clinical interviewers, the Confusion Assessment Method (CAM) has become widely used. This study used the CAM to determine the rate of postoperative delirium in patients undergoing total hip arthroplasty (THA) and total knee arthroplasty (TKA) procedures under regional anesthesia. Following Institutional Review Board approval, a prospective study of 20 patients per group ages 70 and above undergoing unilateral THA or TKA was initiated. Both groups received a combined spinal–epidural, postoperative patient-controlled epidural anesthesia, and postoperative oral opioids. Patient interviews occurred five times: once preoperatively and two times each on post-operative days 1 and 2. Only two patients were assessed as delirious according to the CAM method (one in each group; 5%). Patient assessment by other clinicians indicated that five additional patients experienced acute change in mental status; however, these patients were not delirious at the times of the study interviews. The rate of delirium in the elderly after arthroplasty performed under regional anesthesia is very low. Reasons for this include patient selection criteria and anesthesia type. The study excluded patients with several proposed risk factors for postoperative delirium: prior history of dementia, history of mental illness, and use of benzodiazepines. The use of regional anesthesia may have also reduced the occurrence of postoperative delirium.

Keywords postoperative delirium · delirium · confusion assessment method · elderly · total knee arthroplasty · total hip arthroplasty · regional anesthesia

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Each author certifies that his or her institution has approved the reporting of these cases, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participating in the study was obtained.

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Level of evidence: Diagnostic study, level III

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Introduction

Delirium is increasingly recognized as a major adverse event occurring postoperatively in elderly surgical patients [13]. Delirium has been associated with adverse clinical and economic outcomes, including higher rates of major complications, poor functional recovery, increased length of stay, and higher costs. Although the etiologic link between delirium and these outcomes is debatable, it is undisputed that delirium is highly distressing to patients, family members, and providers [1], indicating a clear need for further research regarding its diagnosis and prevention.

The disparate reported incidence of delirium after surgery (from 2% to 60%) reflects differences in the diagnostic criteria for delirium, the population under study, and the method of postoperative surveillance for delirium. Delirium incidence following orthopedic procedures is also dependent on urgency of the procedure and underlying frailty of the patient population. After hip fracture, rates of postoperative delirium can be as high as 61% [12]. Williams-Russo et al. reported a 41% incidence of postoperative delirium in elderly non-demented patients following bilateral total knee arthroplasty (TKA), based on application of diagnostic criteria articulated in the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders [15]. On the other hand, Lynch et al. reported a 6% and 16% incidence of postoperative delirium after total hip arthroplasty (THA) and TKA, respectively, using a telephone interview for cognitive status (a modified version of the Mini-Mental State Examination) on postoperative days 1 through 3 [9].

Studies aimed at reducing rates of postoperative delirium require a validated, reproducible instrument. Because of the accuracy, brevity, and ease of use by clinical interviewers, the Confusion Assessment Method (CAM) has become the most widely used standardized delirium instrument for clinical and research purposes over the past 16 years [5]. It has been adopted for use in a variety of settings such as the intensive care unit [2], emergency rooms [8], and at home via telephone surveys [10]. The CAM was developed to allow non-psychiatrically trained personnel (either clinical or research staff) to quickly and accurately identify patients with delirium.

The primary purpose of this study was to determine the incidence rate of postoperative delirium in patients undergoing THA and TKA procedures. The secondary purpose was to determine if the CAM is a reliable and practical method for the use and evaluation of postoperative delirium in our institution.

Patients and Methods

This prospective cohort study was approved by the Institutional Review Board of Hospital for Special Surgery. All patients gave informed written consent. Inclusion criteria were patients scheduled for either unilateral TKA or unilateral THA, and age of 70 years or greater. The study was completed with 20 patients in each group (40 total). As this study was meant as a feasibility study, sample size and power analyses were not relevant. Patients were selected based on eligibility criteria and the availability of the research staff to conduct the required postoperative interviews. Patients were considered eligible to enroll in the study if the attending anesthesiologist planned to administer anesthetic and analgesic treatments most frequently utilized for the respective procedures. Exclusion criteria included failure to follow the anesthetic plan, such as any patient intending to receive general anesthesia or patients enrolled into low-opioid protocols. Chronic opioid or benzodiazepine use (taking medications for longer than 3 months), patients with central nervous system disease including dementia and Parkinson's disease were exclusion criteria as well because these preexisting conditions may be risk factors for delirium. Communication issues such as severe hearing disorders or diminished ability to communicate in English also excluded patients from study participation.

The database was maintained in Microsoft Excel version 2002 for Windows (Microsoft Corporation, Redmond, WA). Basic demographic data and ASA status were recorded from patient medical records. An equal number of male and female THA patients were enrolled whereas 70% of TKA patients enrolled were female. Overall, the average patient enrolled had a mean age of 78±5 years, with a BMI of 27. Sixty percent of THA patients were considered at least overweight (BMI >25) compared to 55% of TKA patients, (Table 1). Among TKA patients, 20 of the 20 patients enrolled completed the study; however, five patients declined to answer questions on at least one postoperative visit. For THA patients, 20 of 24 patients enrolled completed the study. All patients were selected based on their eligibility and assessor availability. Four patients were excluded from the data analysis because they did not receive the standard postoperative analgesia. Of these, two patients did not receive any type of patient-controlled analgesia (PCA), one patient's planned anesthetic treatment included an intravenous PCA instead of the standard epidural PCEA, and one patient received a low-opioid mixture of IV PCA clonidine 1 mcg and 0.06% bupivacaine. An additional six patients declined to be interviewed for at least one postoperative visit.

Intraoperative treatment consisted of a combined spinal–epidural anesthetic for both patient groups, as well as a femoral nerve block [16] for TKA patients. Postoperative pain management consisted of patient-controlled epidural analgesia (bupivacaine 0.06%+hydromorphone 10 mcg/ml) until noon of the second postoperative day for TKA patients or until noon of the first day following the surgery for THA patients. For both groups, the postoperative analgesic plan also included oral opioids. These criteria were established because the described anesthetic and analgesic plans are considered the standard at HSS, and it was thought best to have a uniform approach.

Three research staff members (MR, CF, and RP) administered the CAM, assessing mental status using nine observational guidelines: acute onset, inattention, disorganized thinking, altered level of consciousness, disorientation, memory impairment, perceptual disturbances, psychomotor agitation/retardation, and altered sleep/wake cycle. Based on the procedure established by the CAM Training Manual and Coding Guide [4], the first four metrics were used to determine the corresponding CAM score at each patient visit. There are a few ways that patients could meet the "delirium scored as present" criteria. They needed to receive scores of "present" on a combination of acute onset, inattention and then either disorganized thinking or altered level of consciousness. Even if there was no acute onset, the patient could still be considered delirious by exhibiting each of the other factors (at least one factor must be seen as fluctuating throughout patient interaction). To do so, research staff used a variety of sources including patient interview, accounts from the patient family members, nursing staff reports, and medical chart review. Research

Table 1 Patient demographic characteristics

Variable	Total hip arthroplasty *n*=20	Total knee arthroplasty *n*=20	Overall *n*=40
Age, years (mean ± SD)	79±5.4	78±3.7	78±4.6
Sex, *n* (%)			
Male	10 (50)	6 (30)	16 (40)
Female	10 (50)	14 (70)	24 (60)
BMI			
Normal (<25)	8 (40)	9 (45)	17 (42.5)
Overweight (25–30)	9 (45)	6 (30)	15 (37.5)
Obese (30–35)	2 (10)	4 (20)	6 (15)
Morbid obese (>35)	1 (5)	1 (5)	2 (5)
ASA			
1	0 (0)	0 (0)	0 (0)
2	12 (60)	14 (70)	26 (65)
3	8 (40)	6 (30)	14 (35)

staff assessed patients in teams until inter-assessor reliability was established. The Digit Span test and the Mini-Mental State Examination (MMSE) [3] were used as the materials for the patient interviews. Both tests have been used in the validation of the CAM [5].

These questions were administered to two groups of patients: THA and TKA. The surveys were administered to each patient on five separate occasions. After enrolling in the study, the survey was administered preoperatively to establish patients' baseline cognitive status. Research staff then interviewed patients via four postoperative visits. Since mental acuity can fluctuate during the course of the day, two distinct daily visits were used in an attempt to accurately capture patient mental status. As such, patients were visited once in the morning and once in the evening during the first and second postoperative days (POD-1 and POD-2, respectively). A minimum of 4–5 h was maintained between the two daily assessments.

Incidence rate of delirium/confusion as determined using the CAM was the primary outcome for the study. A descriptive analysis of other study variables was also performed.

Results

The incidence rates for postoperative delirium for elderly THA and TKA patients, as defined by the CAM, were very low (5%). Overall, only two patients received a CAM score of 1, or "delirium scored as present" during the course of all four postoperative evaluations over a 2-day period. This represented a 5% incidence rate of postoperative delirium for THA patients and 5% incidence rate for TKA patients (Table 2). Each of these patients showed acute onset of changes to mental status. For five additional patients, assessors determined that the patient had experienced acute onset of mental status changes but received a CAM score of 2, or "delirium absent". This occurred during seven additional patient visits (four TKA and three THA) as two patients displayed acute mental status changes on multiple occasions. This was determined via patient interview or reported by the treating clinical staff. Based on the resulting interviews, however, these patients did not meet the predetermined study criteria for delirium. The most frequent reason for an acute onset of change to mental status was patient disorientation. In six of the nine instances of acute mental status changes that occurred prior to a study visit, the patients believed that they were at home as opposed to in the hospital. "Inattention" represented any time that a patient had difficulty focusing or was easily distractible. Inattention was the most frequently observed symptom. Assessors determined that 16 of the 40 patients analyzed displayed inattention on the first postoperative visit, 7 THA patients and 9 TKA patients. The rate of inattention remained relatively consistent between each visit. There were 15 patients that displayed inattention on the second postoperative visit (8 THA and 7 TKA), 16 patients on the third postoperative visit, and 13 patients on the final postoperative visit.

The CAM can be considered a reliable and easy method for detection of postoperative delirium. There were three individual research staff members interviewing patients in total, and the administering research staff interviewed each individual patient in teams of two in order to develop concordance on their assessments for the same patients. This means that each researcher gave the same patient the same ratings during each patient interview. The research staff members administering the patient interviews had no prior experience assessing mental acuity. It took the teams of two staff members only five to ten postoperative visits in order to develop concordance on their assessments for the same patients. The prompt manner with which this occurred signifies the ease with which the CAM can be learned and implemented by non-psychiatric professional staff.

Discussion

Postoperative delirium is an increasing problem. This is particularly true for elderly patients. Given the projected aging of the population, which will result in more elderly patients presenting for surgery, postoperative delirium is likely to continue to be a prevalent condition. Our study sought to determine the incidence rate of postoperative

Table 2 The overall confusion assessment method scoring

Observed symptom	Postoperative visit 1: POD-1 A.M.			Postoperative visit 2: POD-1 P.M.			Postoperative visit 3: POD-2 A.M.			Postoperative visit 4: POD-2 P.M.		
	THA *n* (%)[a]	TKA *n* (%)[a]	Overall *n* (%)[a]	THA *n* (%)[a]	TKA *n* (%)[a]	Overall *n* (%)[a]	THA *n* (%)[a]	TKA *n* (%)[a]	Overall *n* (%)[a]	THA *n* (%)[a]	TKA *n* (%)[a]	Overall *n* (%)[a]
Acute onset	1 (5.3)	3 (15)	4 (10.3)	1 (5.6)	0 (0.0)	1 (2.9)	1 (5.6)	2 (11.8)	3 (8.6)	1 (5)	0 (0.0)	1 (2.6)
Inattention	7 (38.9)	9 (47.4)	16 (43.2)	8 (44.4)	7 (43.8)	15 (44.1)	9 (50.0)	7 (41.2)	16 (45.7)	6 (31.6)	7 (36.8)	13 (34.2)
Fluctuating behavior[b]	3 (16.7)	1 (5.3)	4 (10.8)	5 (27.8)	4 (25.0)	9 (26.5)	2 (11.1)	2 (11.8)	4 (11.4)	0 (0.0)	2 (10.5)	2 (5.3)
Disorganized thinking	0 (0.0)	2 (10.5)	2 (5.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Fluctuating behavior[b]	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Altered level of consciousness	0 (0.0)	4 (20.0)	4 (10.5)	1 (5.6)	1 (6.3)	2 (5.9)	1 (5.6)	4 (23.5)	5 (14.3)	0 (0.0)	2 (10.5)	2 (5.3)
Fluctuating behavior[b]	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Disorientation	4 (22.2)	4 (21.1)	8 (21.6)	5 (27.8)	2 (12.5)	7 (20.6)	1 (5.6)	6 (35.3)	7 (20.0)	4 (21.1)	3 (15.8)	7 (18.4)
Fluctuating behavior[b]	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (6.3)	1 (2.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Memory impairment	5 (27.8)	11 (57.9)	16 (43.2)	8 (44.4)	9 (56.3)	17 (50)	5 (27.8)	5 (29.4)	10 (28.6)	5 (26.3)	5 (26.3)	5 (26.3)
Fluctuating behavior[b]	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Perceptual disturbances	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Fluctuating behavior[b]	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Psychomotor agitation	0 (0.0)	1 (5.3)	1 (2.7)	0 (0.0)	1 (6.3)	1 (2.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Fluctuating behavior[b]	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Psychomotor retardation	0 (0.0)	1 (5.3)	1 (2.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Fluctuating behavior[b]	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Altered sleep–wake cycle	4 (22.2)	3 (15.0)	7 (18.4)	3 (16.7)	0 (0.0)	3 (8.8)	3 (15.0)	4 (23.5)	7 (18.9)	2 (10.5)	3 (15.8)	5 (13.2)
Overall CAM score[c] (delirium present)	0 (0.0)	1 (5.0)	1 (2.6)	1 (5.0)	0 (0.0)	1 (2.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

POD postoperative day, *THA* total hip arthroplasty, *TKA* total knee arthroplasty, *CAM* confusion assessment method

[a] The number of patients per postoperative visit that displayed the symptom described is represented by *n*. The percentage was then calculated by dividing *n* by the total number of people who completed that particular interview, i.e., postoperative visit 1

[b] Fluctuating behavior was defined as increasing and decreasing severity of the symptom/behavior in question during the interview

[c] Overall CAM is defined as any patient that received scores of "present" on a combination of acute onset, inattention, and either disorganized thinking or altered level of consciousness

Table 3 The mini-mental state examination

	Total hip arthroplasty	Total knee arthroplasty	Overall
Preoperative			
Average score, (mean ± SD)	28±1.7	28±1.7	28±1.7
No cognitive impairment (24–30), *n* (%)	19 (95)	20 (100)	39 (97.5)
Mild cognitive impairment (18–23), *n* (%)	1 (5)	0 (0.0)	1 (2.5)
Severe cognitive impairment (0–17), *n* (%)	0 (0.0)	0 (0.0)	0 (0.0)
Postoperative visit 1 (POD-1 A.M.)[a]			
Average score, (mean ± SD)	27±2.2	27±1.9	27±2.0
No cognitive impairment (24–30), *n* (%)	18 (100)	18 (94.7)	36 (97.3)
Mild cognitive impairment (18–23), *n* (%)	0 (0.0)	1 (5.3)	1 (2.7)
Severe cognitive impairment (0–17), *n* (%)	0 (0.0)	0 (0.0)	0 (0.0)
Postoperative visit 2 (POD-1 P.M.)[b]			
Average score, (mean ± SD)	27±2.3	27±2.3	27±2.3
No cognitive impairment (24–30), *n* (%)	16 (94.1)	14 (87.5)	30 (90.9)
Mild cognitive impairment (18–23), *n* (%)	1 (5.9)	2 (12.5)	3 (9.1)
Severe cognitive impairment (0–17), *n* (%)	0 (0.0)	0 (0.0)	0 (0.0)
Postoperative visit 3 (POD-2 A.M.)[a]			
Average score, (mean ± SD)	28±1.5	27±2.5	28±2.1
No cognitive impairment (24–30), *n* (%)	18 (100)	14 (87.5)	32 (94.1)
Mild cognitive impairment (18–23), *n* (%)	0 (0.0)	2 (12.5)	2 (5.9)
Severe cognitive impairment (0–17), *n* (%)	0 (0.0)	0 (0.0)	0 (0.0)
Postoperative visit 4 (POD-2 PM)[b]			
Average score, (mean ± SD)	29±1.6	27±1.8	28±1.8
No cognitive impairment (24–30), *n* (%)	18 (100)	18 (100)	36 (100)
Mild cognitive impairment (18–23), *n* (%)	0 (0.0)	0 (0.0)	0 (0.0)
Severe cognitive impairment (0–17), *n* (%)	0 (0.0)	0 (0.0)	0 (0.0)

[a] Visit in the morning

[b] Visit in the afternoon

delirium in patients undergoing THA and TKA procedures under regional anesthesia. At our institution, the incidence rates for postoperative delirium for elderly THA and TKA patients, as defined by the CAM, were very low (5%). The results of the MMSE further validated the findings with the CAM. The MMSE was used as a basis for the in-person interviews during each visit; however, it is also a validated scale for the evaluation of cognitive impairment (Table 3) [14]. During all four postoperative visits, only six of the 107 completed interviews showed a patient with any cognitive impairment. This equated to only five patients (four TKA and one THA) of the 40 enrolled that displayed cognitive impairment as determined by the MMSE. Each of these instances was considered mild cognitive impairment by the standards set forth in the MMSE.

There are several limitations for this study. Postoperative delirium often waxes and wanes. Although the observed rate of confusion was low, approximately 12.5% of patients demonstrated symptoms consistent with delirium within 48 h after surgery. These symptoms were short-lived, however, and were not apparent at the time of assessment. Not all patients completed all four postoperative interviews. Five TKA patients and six THA patients declined the interview on at least one occasion. The reasons for patient refusal varied, but none of these patients displayed confused or delirious behavior. Therefore, their data were included in the analysis. Additionally, the questions asked during patient interviews fluctuated only slightly; therefore, the frequency of patient interviews allowed astute patients to learn the interview format and offer more correct answers. This low incidence rate of postoperative delirium may also reflect patient selection—these are elective procedures and patients may have fewer comorbidities than, for example, hip fracture patients. While elderly patients are at increased risk for postoperative delirium, the inclusion criteria limited that risk. By excluding patients with prior history of dementia, mental illness, and chronic use of benzodiazepines [7], we did not study patients with some of the proposed risk factors for postoperative delirium. One of the reasons that these patients were excluded was the likelihood that many of the excluded patients would be prescribed a low-opioid regimen designed to limit narcotic side effects (such as postoperative delirium). Regional anesthesia offers several benefits compared to general anesthesia, potentially including reduced occurrence of postoperative delirium which serves to limit the risk posed to our patient population.

Lynch et al. reported a similar incidence rate of postoperative delirium after THA procedures (6%) [9]. In a study performed by KJ Kalisvaart et al. on risk factors of postoperative delirium in elderly hip surgery patients, those patients considered “low” or “intermediate risk” for postoperative delirium also showed extremely low rates of postoperative delirium (3.8% and 11.2%, respectively) [6]. As previously stated, our exclusion criteria similarly limited the risk of postoperative delirium for our patients enrolled. In fact, only one patient received a score of “mild cognitive impairment” during their preoperative patient assessment. The reported rate of delirium following TKA in the Lynch study was much higher (15.5%) than that of our study [9]. However, the Lynch study concentrated on delirium as it related to postoperative pain and did not study surgeries with a standardized intraoperative anesthetic technique. In a meta-analysis performed by SE Mason, the investigators determined that general anesthesia may increase the risk of developing postoperative cognitive dysfunction when compared to other types of anesthesia such as the regional techniques used as standard practice in our institution (as defined by Mason et al., postoperative delirium itself was not adversely affected by anesthesia type) [11]. Williams-Russo et al. study of delirium following bilateral TKA procedures did use a standardized anesthetic technique, and yet reported an even greater incidence of postoperative delirium in elderly non-demented patients (41%) [15]. However, Williams-Russo used an alternative technique for determining patient cognitive levels after surgery.

In conclusion, the CAM revealed a very low incidence rate of postoperative delirium for elderly patients presenting for elective total knee or total hip arthroplasty at Hospital for Special Surgery. It can be considered a reliable and easy method to assess for postoperative delirium and confusion among older patients undergoing elective TKR and THR.

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References

1. Bruera E, Bush SH, Willey J, Paraskevopoulos T, Li Z, Palmer JL, Cohen MZ, Sivesind D, Elsayem A. Impact of delirium and recall on the level of distress in patients with advanced cancer and their family caregivers. Cancer 2009;115:2004–12
2. Ely EW. Delirium in mechanically ventilated patients; validity and reliability of the Confusion Assessment Method for the intensive care unit (CAM-ICU). JAMA. 2001;286:2703–10
3. Folstein MF, Folstein SE, McHugh PR. “Mini-mental state”. A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12(3):189–98
4. Inouye SK. The Confusion Assessment Method (CAM): Training Manual and Coding Guide. 2003; New Haven: Yale University School of Medicine.
5. Inouye SK, Van Dyck CH, Alessi CA, Balkin S, Siegal AP, Horwitz RI. Clarifying confusion: The Confusion Assessment Method. A New method for detection of delirium. Ann Intern Med 1990:113:941–8
6. Kalisvaart KJ, Vreeswijk R, de Jonghe JFM, van der Ploeg T, van Gool WA, Eikelenboom P. Risk factors and prediction of postoperative delirium in elderly hip-surgery patients: implementation and validation of a medical risk factor model. J Am Geriat Soc 2006;54:817–22
7. Kudoh A, Takse H, Takahira Y, Takazawa T. Postoperative confusion increases in elderly long-term benzodiazepine users. Anesth Anal 2004;99:1674–8
8. Lewis LM, Miller DK, Morley JE, Nork MJ, Lasater LC. Unrecognized delirium in ED geriatric patients. AM J Emerg Med. 1995;13:142–5
9. Lynch EP, Lazor MA, Gellis JE, Orav J, Goldman L, Marcantonio ER. The impact of postoperative pain on the development of postoperative delirium. Anesth Analg 1998;86:781–5
10. Marcantonio ER, Michaels M, Resnick NM. Diagnosing delirium by telephone. J Gen Intern Med. 1998;13:621–3

11. Mason SE, Noel-Storr A, Ritchie CW. The impact of general and regional anesthesia on the incidence of post-operative cognitive dysfunction and post-operative delirium: a systematic review with meta-analysis. J Alzheimers Dis 2010;22 Suppl 3:67–79
12. Morrison RS, Chassin MR, Siu AL. The medical consultant's role in caring for patients with hip fracture. Ann Intern Med 1998;128:1010–20
13. Ramaiah R, Lam AR. Postoperative Cognitive Dysfunction in the Elderly. Anesthesiology Clin 2009;27:485–96
14. Tombaugh TN, McIntyre NJ. The mini-mental state examination: a comprehensive review. J Am Geriatr Soc 1992;40 (9):922–35
15. Williams-Russo P, Urquhart B, Sharrock N, Charlson M. Post-operative delirium: predictors and prognosis in elderly orthopedic patients. J Am Geriatr Soc 1992;40:759–67
16. YaDeau JT, Cahill JB, Zawadsky MW, Sharrock NE, Bottner F, Morelli CM, Kahn RL, Sculco TP. The effects of femoral nerve blockade in conjunction with epidural analgesia after total knee arthroplasty. Anesth Analg 2005;101:891–5