Frequency, Risk Factors, and Prognosis of Prolonged Delirium in Elderly Patients After Hip Fracture Surgery

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Abstract

Background Delirium in elderly patients after hip fracture surgery is believed to be a transient event, although it frequently lasts for more than 4 weeks.

Questions/purposes We determined the incidence, risk factors, morbidity, and mortality of prolonged delirium in elderly patients after hip fracture surgery.

Patients and Methods We evaluated 232 elderly patients (older than 65 years) (232 hips) who underwent hip fracture surgery for the development and duration of delirium and categorized them into three groups; nondelirium group, transient (≤ 4 weeks) delirium group, and prolonged (> 4 weeks) delirium group. Patients underwent a global geriatric evaluation, which included postoperative

complications, mortality, and functional and mental status evaluations. The three groups were compared with respect to these variables.

Results Seventy patients (30.2%) had delirium develop, and among these, 14 (20%) had prolonged delirium with a total incidence of 6%. Multivariate analysis showed preinjury dementia was a risk factor of prolonged delirium. At the final followup, five (62.5%) of the eight patients who were ambulatory outdoors in the prolonged delirium group became housebound, whereas only 18 (16.4%) of the 110 patients who were ambulatory outdoors in the nondelirium group became housebound. Survival at 40 months was 81.0% (95% confidence interval, 72.6%–89.3%) in the nondelirium group and 63.6% (95% confidence interval, 35.2%–92.1%) in the prolonged delirium group.

Conclusions Prolonged delirium was found to be associated with a poor functional outcome and increased mortality. **Level of Evidence** Level II, prognostic study. See Guidelines for Authors for a complete description of levels of evidence.

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Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

This work was performed at Chung-Ang University College of Medicine.

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Introduction

Delirium is a common complication in elderly patients after hip fracture surgery, characterized by a change in mental status with attention and awareness deficits, loss of cognitive and perceptive functions, and alterations in the sleep cycle [15, 29]. Delirium also is associated with adverse outcomes, including greater hospitalization time, greater rate of institutional placement, greater dependence on others, higher costs, delayed recovery, and increased mortality [6, 10, 15].

The incidence of delirium in the elderly is known to be higher after hip fracture (range, 28%–61%) than after

admission to a general internal medicine unit or an acute geriatric unit (range, 14%–42%) [6, 10, 12, 17, 25, 39]. In nonorthopaedic fields, a chronic type of delirium, which is called prolonged delirium (defined here as lasting > 4 weeks), is reported to exist and is known to be associated with greater mortality and poor functional recovery [4, 21, 22]. However, the duration of delirium and its consequences have received sparse attention in the orthopaedic field.

Our study was designed to answer to the following questions: (1) What was the incidence of prolonged delirium after surgical treatment of patients with hip fracture? (2) Could any risk factors associated with prolonged delirium be identified? (3) How did the morbidity and mortality compare between patients who experienced delirium and those who did not?

Patients and Methods

We reviewed prospectively collected data on 250 patients aged 65 years and older who underwent surgery for a femoral neck fracture or an intertrochanteric fracture from January 2006 to December 2008 in a tertiary referral center. Of the 250 patients, 18 (7.2%), who refused followup after discharge, were excluded from this study (Fig. 1). Thus, we analyzed 232 patients who were followed for a minimum of 12 months or until their death after the fracture operation. The average age of patients was 79 years (range, 65–97 years); 59 patients were male and 173 patients were female. Development and duration of delirium were evaluated using the Confusion Assessment Method (CAM) (Table 1) [2]. All patients underwent global clinical and geriatric evaluations, including history, physical examination, laboratory tests, and a surgical risk evaluation. The design and protocol of this prospective study were approved by the institutional review board at the authors' hospital, and all patients provided informed consent.

The presence of preoperative cognitive impairment/dementia was determined within 24 hours of admission using the Mini-Mental State Examination (MMSE) and the CAM diagnostic algorithm [8, 9, 15]. One orthopaedic surgeon (BGC) and two nurses (HJO, SN) who had been trained for the evaluation of CAM and mental status collected the data. One psychiatric doctor, who specialized in dementia, participated in the design of this study, and we consulted the psychiatric department for evaluation of the patient's mental status whenever the patients had abnormal scores for the MMSE and abnormal CAM during the initial hospitalization and postoperative period. Through this consultation, the patients were classified to have dementia or delirium. Normal mental status was defined as a MMSE score of 25 points or more (maximum score is 30). Scores of 19 or less were interpreted as definite dementia and

scores of 20 to 24 as suspected dementia [23, 34]. In patients with suspected dementia, a diagnosis of dementia was made with consideration of the age, gender, and education level of the patient [23, 34]. CAM scores are determined using a diagnostic algorithm consisting of four features: (1) acute and fluctuating changes in mental status, (2) inattention, (3) disorganized or incoherent thinking, and (4) an altered level of consciousness. CAM scores are considered to indicate delirium if Features 1 and 2 are present and either Feature 3 or 4 is present.

As previous studies reported most patients with hip surgery who have delirium develop recover within 4 weeks [6, 10, 12, 24, 38], we defined "transient delirium" as delirium lasting for 4 weeks or less postoperatively and "prolonged delirium" as delirium lasting more than 4 weeks. Patients were categorized into three groups: (1) a transient delirium group, (2) a prolonged delirium group, and (3) a nondelirium group.

Postoperative delirium was assessed 2 or 3 days postoperatively. Assessment was not performed on the day of surgery because of the difficulty in differentiating true delirium and the residual effects of anesthesia. A second evaluation was performed 1 week postoperatively.

One hundred eleven patients included in the study experienced a delay to the time of surgery after admission for more than 5 days. The reason for delay included the need to allow reversal of anticoagulation for patients receiving aspirin or warfarin, or the need for preoperative evaluations of comorbidities. Of the 232 patients, 204 underwent cementless bipolar hemiarthroplasty and the remaining 28 underwent internal fixation using a dynamic compression hip screw.

We assessed patient characteristics, including age, gender, body mass index (BMI), medical comorbidity, fracture type, presence of preoperative dementia, presence of preoperative delirium, surgical delay, type of anesthesia, duration of anesthesia, amount of blood loss, type of operation (hip arthroplasty or internal fixation), hospitalization after surgery, and surgical risk on the American Society of Anesthesiologists (ASA) rating scale [35] (Classes I and II or Classes III and IV), to determine whether they contributed to the occurrence and duration of delirium. Medical comorbidities were assessed using the modified Charlson's Comorbidity Index, which is calculated by summing points awarded for disease conditions as follows: 1 point for myocardial infarction, congestive heart failure, deep vein thrombosis, peripheral vascular disease, dementia, chronic obstructive pulmonary disease, arthritis, ulcers, or diabetes; 2 points for cancer or stroke; and 3 points for cirrhosis. Thus, possible total scores range from 0 to 15, where higher scores indicate a poorer health status [2].

Patients were followed up at 1, 3, 6, and 12 months postoperatively and every 6 months thereafter. At each

Fig. 1 A flowchart shows the flow of patients through the study.

Table 1. Confusion Assessment Method diagnostic algorithm

Feature	Description
Feature 1: acute onset and fluctuating course	This feature is usually obtained from a family member or nurse and is shown by positive responses to the following questions: Is there evidence of an acute change in mental status from the patient's baseline? Did the (abnormal) behavior fluctuate during the day, that is, tend to come and go, or increase and decrease in severity?
Feature 2: inattention	This feature is shown by a positive response to the following question: Did the patient have difficulty focusing attention, for example, being easily distractible, or having difficulty keeping track of what was being said?
Feature 3: disorganized thinking	This feature is shown by a positive response to the following question: Was the patient's thinking disorganized or incoherent, such as rambling or irrelevant conversation, unclear or illogical flow of ideas, or unpredictable switching from subject to subject?
Feature 4: altered level of consciousness	This feature is shown by any answer other than "alert" to the following question: Overall, how would you rate the patient's level of consciousness? (alert [normal]), vigilant [hyperalert], lethargic [drowsy, easily aroused], stupor [difficult to arouse], or coma [unarousable])

The diagnosis of delirium requires the presence of Features 1 and 2 and either Feature 3 or 4; (Reprinted with permission from Inouye SK, van Dyck CH, Alessi CA, Balkin S, Siegel AP, Horwitz RI. Clarifying confusion: the Confusion Assessment Method. A new method for detection of delirium. *Ann Intern Med.* 1990;113:941–948. The American College of Physicians is not responsible for accuracy of this translation.)

visit, patients were interviewed using a questionnaire that addressed activity level, and MMSE and CAM scores were determined. Postoperative functional outcomes were evaluated using activity levels [33], which were defined as follows: I, normal; II, essentially independent outdoors but requiring help with some activities; III, independent indoors but always requiring help outdoors; IV, not independent indoors but able to transfer and walk independently; and V, confined to bed or chair and not ambulatory. Patients unable to return for followup were interviewed, using a questionnaire, by telephone and were requested to send radiographs. The followups were made taking care to interview the same caregiver who was interviewed during the patient's hospitalization. This clinical information was collected by one orthopaedic surgeon (BGC) and two nurses (HJO, SN). Seventy-eight patients completed followups with a telephone interview.

Of the 232 patients, all patients had a face-to-face interview at the outpatient clinic at 3 months. However, 41 patients were interviewed by telephone at 6 months, 53 patients at 12 months, 30 patients at 18 months, 24 patients at 24 months, and 16 patients at 36 to 40 months.

Mortality was identified from hospital records or by interviewing a member of the family of the patient involved.

We analyzed the morbidity in patients, who were still alive until the latest followup, which was performed 12 to 40 months postoperatively. The activity levels of patients were dichotomized into ambulatory outdoors (activity levels of I and II) and housebound (activity levels of III, IV, and V) for the analysis.

We used multiple logistic regression analysis to identify the factors that effectively influenced the development of transient delirium and prolonged delirium. First, demographic and clinical variables between patients with nondelirium and patients with transient and prolonged delirium were compared using the independent t test for continuous variables and the chi square test or Fisher's exact test for categorical data. For p values less than 0.10 by univariate analysis, multiple logistic regression analysis with stepwise selection was performed. In the multivariate analysis model, age, ASA class, operation type, and preoperative dementia were included for comparison between the nondelirium and the total delirium groups (transient and prolonged delirium groups), and preoperative dementia and BMI were included for comparison between the nondelirium and the prolonged delirium groups. The Kaplan-Meier product-limit method with log-rank significance test was used to estimate survival [19] using mortality as an end point. All reported p values are two sided, and p values less than 0.05 were deemed significant. SPSS[®] Version 15.0 (SPSS Inc, Chicago, IL, USA) was used for the statistical analyses.

Results

Of the 232 study subjects, 162 patients did not have delirium develop and 70 (30.2%) did, and of these 70, 56 (80%) had transient delirium and 14 (20%) had prolonged delirium, resulting in an incidence of prolonged delirium of 6% (Table 2). In the transient delirium group, 50 patients recovered within 7 days and six patients between 10 and 28 days. In the prolonged delirium group, 12 patients recovered between 40 and 160 days (mean, 98 days) and two patients did not recover by the final followup of 18 and 20 months, respectively (Fig. 1).

ASA class ($p = 0.003$), operation type ($p = 0.004$), preoperative delirium ($p = 0.008$), and dementia ($p = 0.009$) were different between the nondelirium group and the total delirium group (transient and prolonged delirium

Table 2. Demographic data

Variable	Value
Number of patients	232
Male:female	59 (25.4%):173 (74.6%)
Age (years)*	79.0 $\pm$ 7.7 (65–97)
Body mass index*	21.5 $\pm$ 3.8 (15.5–36.0)
Residence before injury	
Home	191 (82.3%)
Nursing home	41 (17.7%)
Diagnosis	
Femoral neck fracture	116 (50%)
Intertrochanteric fracture	116 (50%)
Medical comorbidities*	2.1 $\pm$ 1.3 (0–8)
Surgical risk assessment (ASA score)	
I	17 (7.3%)
II	132 (56.9%)
III	82 (35.3%)
IV	1 (0.4%)
Duration of anesthesia (minutes)*	95.1 $\pm$ 35.2 (65–180)
Amount of transfusion (mL)*	311.2 $\pm$ 166.7 (0–1200)
Delay of operation (days)*	5.4 $\pm$ 5.9 (0–60)
Operation method	
Arthroplasty	204 (87.9%)
Internal fixation	28 (12.1%)
Preoperative mental change	
Delirium	4 (1.7%)
Dementia	10 (4.3%)
Postoperative delirium	70 (30.2%)
Transient	56 (80.0%)
Prolonged	14 (20.0%)

* Values are expressed as mean $\pm$ SD, with range in parentheses; the remaining values are expressed as number of patients, with percentage in parentheses; ASA = American Society of Anesthesiologists

groups) in univariate analysis (Table 3). However, only dementia ($p = 0.011$) and operative type ($p = 0.029$) were associated with the development of delirium in multivariate analysis. Comparing the nondelirium group and the prolonged delirium group, univariate analysis showed differences with respect to dementia ($p = 0.007$) and BMI ($p = 0.048$), and multivariate analysis showed preoperative dementia to be associated with development of prolonged delirium ($p = 0.003$) (Table 4). Comparing the transient and prolonged delirium groups, no differences were found between the two groups.

Thirty-nine patients (16.8%) died after discharge. Overall mortalities after surgery were 7.3% (17 of 232) at 6 months, 9.5% (22 patients) at 12 months, and 12.5% (29 patients) at 24 months. Mortalities at 24 months in the prolonged delirium and nondelirium groups were 12.3% (20 of 162) and 35.7% (five of 14), respectively ($p = 0.032$), and mortalities at this time in the transient delirium group (seven of 56) and the prolonged delirium group (five of 14) differed with marginal significance

($p = 0.054$). Survival rates at 40 months were 81.0% (95% confidence interval, 72.6%–89.3%) in the nondelirium group, 73.5% (95% confidence interval, 51.8%–95.2%) in the transient delirium group, and 63.6% (95% confidence interval, 35.2%–92.1%) in the prolonged delirium group (Fig. 2).

For 193 patients who survived 1 year or longer after the operation, the development of delirium was associated with a higher incidence of reduced activity level at followup. Patients with poorer activity level after surgery at the final followup included 35 of the 136 surviving members in the nondelirium group, 20 of 48 in the transient delirium group, and eight of nine in the prolonged delirium group ($p < 0.001$) (Table 5). At the final followup, 18 of 110 (16.4%) patients in the nondelirium group and 12 of 38 (31.6%) in the transient delirium group were able to ambulate outdoors. Five of eight (62.5%) patients in the prolonged delirium group who were able to ambulate outdoors were housebound at the final followup ($p = 0.003$) (Fig. 3).

Table 3. Comparison of demographic and clinical data of the nondelirium and delirium groups

Variable	Nondelirium group (n = 162)	Total delirium group* (n = 70)	p Value
Male:female	38:124	21:49	0.293
Age (years) [†]	78.5 ± 7.7	80.3 ± 7.4	0.090
Body mass index [†]	21.7 ± 3.6	21.2 ± 4.0	0.371
Diagnosis			0.567
Femoral neck fracture	79	37	
Intertrochanteric fracture	83	33	
Medical comorbidities [†]	2.1 ± 1.4	2.4 ± 1.4	0.305
Surgical risk assessment (ASA score)			0.003
I	16	1	
II	94	38	
III	52	30	
IV	0	1	
Type of anesthesia			0.127
Spinal	133	63	
General	29	7	
Duration of anesthesia (minutes) [†]	95.9 ± 35.7	95.2 ± 35.1	0.623
Amount of transfusion (mL) [†]	310.5 ± 164.7	311.7 ± 172.4	0.959
Delay of surgery (days) [†]	5.1 ± 5.1	6.0 ± 7.6	0.338
Hospitalization after surgery (days)	13.9 ± 2.2	14.5 ± 2.4	0.072
Type of surgery			0.004
Arthroplasty	136	68	
Internal fixation	26	2	
Preoperative mental change			
Delirium	0	4	0.008
Dementia	3	7	0.009

* Total delirium group = transient delirium group + prolonged delirium group; [†]values are expressed as mean ± SD; the remaining values are expressed as number of patients; ASA = American Society of Anesthesiologists.

Table 4. Comparison of demographic and clinical data of the nondelirium and prolonged delirium groups

Variable	Nondelirium group (n = 162)	Prolonged delirium group (n = 14)	p Value
Male:female	38:124	1:13	0.310
Age (years)*	78.5 ± 7.7	81.9 ± 8.4	0.114
Body mass index*	21.7 ± 3.6	19.6 ± 3.3	0.048
Diagnosis			0.671
Femoral neck fracture	79	6	
Intertrochanteric fracture	83	8	
Medical comorbidities*	2.1 ± 1.4	2.8 ± 2.0	0.122
Surgical risk assessment (ASA score)			0.401
I	16	0	
II	94	8	
III	52	6	
IV	0	0	
Duration of anesthesia (minutes)*	95.9 ± 35.7	96.3 ± 37.1	0.101
Amount of transfusion (mL)*	310.5 ± 164.7	351.4 ± 273.2	0.403
Delay of surgery (days)*	5.1 ± 5.1	8.9 ± 14.94	0.362
Type of surgery			0.104
Arthroplasty	136	14	
Internal fixation	26	0	
Preoperative mental change			
Delirium	0	1	0.080
Dementia	3	3	0.007

* Values are expressed as mean ± SD; the remaining values are expressed as number of patients; ASA = American Society of Anesthesiologists.

Fig. 2 Kaplan-Meier survival curves show the survival rates at 40 months were 81.0%, 73.5%, and 63.6% for the nondelirium, transient delirium, and prolonged delirium groups, respectively.

Discussion

Delirium is a common complication in elderly patients after hip fracture surgery [29], which is associated with a greater hospitalization time, greater rates of institutional

Table 5. Changes in activity level in the three groups

Variable	Nondelirium group (n = 136)	Transient delirium group (n = 48)	Prolonged delirium group (n = 9)	p Value
Preinjury activity				0.566
Grade I	86	29	6	
Grade II	24	9	2	
Grade III	23	7	0	
Grade IV	3	3	1	
Activity at final followup				0.017
Grade I	63	19	0	
Grade II	29	7	3	
Grade III	28	7	3	
Grade IV	13	9	2	
Grade V	3	6	1	
Number of patients with decreased activity	35	28	8	< 0.001

placement, greater dependence on others, higher costs, delayed recovery, and increased mortality [6, 10, 15, 37]. However, the duration of delirium has received little

Fig. 3 An illustration shows activity changes in the nondelirium, transient delirium, and prolonged delirium groups at final followup. Eighteen of 110 (16.4%) patients in the nondelirium group and 12 of 38 (31.6%) in the transient delirium group were able to ambulate outdoors. Five of eight (62.5%) patients in the prolonged delirium group who were able to ambulate outdoors were housebound at final followup ($p = 0.003$).

attention, which is known to be associated with worse outcome in nonorthopaedic fields. In this study, we sought to determine the incidence, risk factor, and clinical outcome of prolonged delirium at a minimum followup of 1 year among elderly patients who underwent surgery for a hip fracture.

This study has several limitations. First, although we used an established and validated method, evaluations were performed at an outpatient clinic, and it occasionally was difficult to differentiate symptoms of dementia and delirium; to determine between dementia and delirium at the admission state, the trained physician and nurse evaluated the patient's mental status using the MMSE and CAM. If the scores were abnormal, the patient has a consultation with the psychiatric department to evaluate his/her mental status and to minimize possible misdiagnosis of delirium to dementia or vice versa. Second, some patients were interviewed by telephone, which increased the risk of misinterpreting the symptoms. To minimize this possibility, the observers who conducted the interview during hospitalization also conducted the telephone interview. Third, the final evaluations were performed over a wide range of intervals (range, 12–40 months) after the operation, and we could not afford to assess the morbidity and mortality at each year after the operation. Finally, this study was conducted at a single tertiary referral center, and thus, caution should be exercised when making generalizations based on our results.

For decades, dementia has been a major public health problem. The rate of dementia among the elderly (65 years and older) has been reported to be approximately 5% to 6% in Western countries [7, 13, 18, 36] and 2% to 7% in Asian countries [3, 27, 28, 41]. In our patients, the rate of dementia was 4%.

Previous studies reported the efficacy of risperidone for the treatment of delirium [14, 42, 44]. In our study, 21

patients with delirium were treated with risperidone. However, we could not determine whether this medication was effective in terms of reducing the severity and duration of delirium because of the lack of randomization and the small sample size in our study.

As previous studies used different criteria to define prolonged delirium [26, 30, 43], no definite definition of prolonged delirium was available. In our study, we defined prolonged delirium as the presence of delirious symptoms for more than 4 weeks postoperatively, referencing the report by Kiely et al. [21]. They defined prolonged delirium as a delirium existing at the 1-month followup, observing most symptoms of delirium recovered within the first 4 weeks [6, 10, 12, 24, 38].

In our study, the incidence of prolonged delirium was 20% (14 of 70) in patients with postoperative delirium and 6% (14 of 232) in all elderly patients, and patients had a mean recovery time of 47 days. The reported incidence of prolonged delirium among patients who have had delirium develop ranges widely from 0% to 61% at 1 month postoperatively [17, 20–22, 40]. The reasons for this wide variation in incidence may be related to differences in patient population, proportions of patients with dementia, the criteria used to determine the presence of delirium at enrollment, and the criteria used to assess prolonged delirium [4, 16, 32].

Preoperative delirium was a single significant risk factor for prolonged delirium compared with the nondelirium group in our study. Previous studies also have reported the presence of preoperative dementia as the strongest risk factor of prolonged delirium among the elderly [16, 21, 31, 32]. Cole et al. [4] explained the relationship between preoperative dementia and prolonged delirium, stating both had similar symptoms, such as inattention and fluctuation, and had similar pathogenesis, which included reduced metabolic rates and impaired cholinergic function, and

similar causative factors, such as excitotoxic neuronal damage and neuron death [1, 5, 11].

In our study, patients with prolonged delirium were found to have worse functional outcome and higher mortality rate than patients who did not have delirium develop. This finding is in concordance with other studies [17, 20, 22]. Kiely et al. [22] reported persistent delirium as a significant independent predictor of 1-year mortality, showing a 2.9 times higher rate of mortality compared with the nondelirium group during the 1-year followup, which diminished after the resolution of delirium.

Prolonged delirium after hip fracture surgery is not rare, shows a higher incidence in patients with preoperative dementia, and is associated with poor functional outcome and higher mortality.

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References

- Blass JP, Gibson GE. Cerebrometabolic aspects of delirium in relationship to dementia. *Dement Geriatr Cogn Disord*. 1999;10:335–338.
- Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 1987;40:373–383.
- Chiam PC, Ng TP, Tan LL, Ong PS, Ang A, Kua EH. Prevalence of dementia in Singapore: results of the National Mental Health Survey of the Elderly 2003. *Ann Acad Med Singapore*. 2004;33(5 suppl):S14–S15.
- Cole MG, Ciampi A, Belzile E, Zhong L. Persistent delirium in older hospital patients: a systematic review of frequency and prognosis. *Age Ageing*. 2009;38:19–26.
- Cole MG, McCusker J, Dendukuri N, Han L. Symptoms of delirium among elderly medical inpatients with or without dementia. *J Neuropsychiatry Clin Neurosci*. 2002;14:167–175.
- Edlund A, Lundstrom M, Lundstrom G, Hedqvist B, Gustafson Y. Clinical profile of delirium in patients treated for femoral neck fractures. *Dement Geriatr Cogn Disord*. 1999;10:325–329.
- Evans DA, Funkenstein HH, Albert MS, Scherr PA, Cook NR, Chown MJ, Hebert LE, Hennekens CH, Taylor JO. Prevalence of Alzheimer's disease in a community population of older persons: higher than previously reported. *JAMA*. 1989;262:2551–2556.
- Fabbri RM, Moreira MA, Garrido R, Almeida OP. Validity and reliability of the Portuguese version of the Confusion Assessment Method (CAM) for the detection of delirium in the elderly. *Arg Neuropsiquiatr*. 2001;59:175–179.
- 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;12:189–198.
- Francis J, Kapoor WN. Prognosis after hospital discharge of older medical patients with delirium. *J Am Geriatr Soc*. 1992;40:601–606.
- Freeman GB, Myktyyn V, Gibson GE. Differential alteration of dopamine, acetylcholine, and glutamate release during anoxia and/or 3,4-diaminopyridine treatment. *Neurochem Res*. 1987;12:1019–1027.
- Gustafson Y, Berggren D, Brannstrom B, Bucht G, Norberg A, Hansson LI, Winblad B. Acute confusional states in elderly patients treated for femoral neck fracture. *J Am Geriatr Soc*. 1988;36:525–530.
- Hofman A, Rocca WA, Brayne C, Breteler MM, Clarke M, Cooper B, Copeland JR, Dartigues JF, da Silva Droux A, Hagnell O, et al. The prevalence of dementia in Europe: a collaborative study of 1980–1990 findings. Eurodem Prevalence Research Group. *Int J Epidemiol*. 1991;20:736–748.
- Horikawa N, Yamazaki T, Miyamoto K, Kurosawa A, Oiso H, Matsumoto F, Nishimura K, Karasawa K, Takamatsu K. Treatment for delirium with risperidone: results of a prospective open trial with 10 patients. *Gen Hosp Psychiatry*. 2003;25:289–292.
- Inouye SK, van Dyck CH, Alessi CA, Balkin S, Siegel AP, Horwitz RI. Clarifying confusion: the confusion assessment method. A new method for detection of delirium. *Ann Intern Med*. 1990;113:941–948.
- Inouye SK, Zhang Y, Jones RN, Kiely DK, Yang F, Marcantonio ER. Risk factors for delirium at discharge: development and validation of a predictive model. *Arch Intern Med*. 2007;167:1406–1413.
- Jitapunkul S, Pillay I, Ebrahim S. Delirium in newly admitted elderly patients: a prospective study. *Q J Med*. 1992;83:307–314.
- Jorm AF, Korten AE, Henderson AS. The prevalence of dementia: a quantitative integration of the literature. *Acta Psychiatr Scand*. 1987;76:465–479.
- Kaplan EL, Meier P. Nonparametric estimation from incomplete observations. *J Am Stat Assoc*. 1958;53:457–481.
- Kelly KG, Zisselman M, Cuttillo-Schmitter T, Reichard R, Payne D, Denman SJ. Severity and course of delirium in medically hospitalized nursing facility residents. *Am J Geriatr Psychiatry*. 2001;9:72–77.
- Kiely DK, Bergmann MA, Jones RN, Murphy KM, Orav EJ, Marcantonio ER. Characteristics associated with delirium persistence among newly admitted post-acute facility patients. *J Gerontol A Biol Sci Med Sci*. 2004;59:344–349.
- Kiely DK, Marcantonio ER, Inouye SK, Shaffer ML, Bergmann MA, Yang FM, Fearing MA, Jones RN. Persistent delirium predicts greater mortality. *J Am Geriatr Soc*. 2009;57:55–61.
- Kim J, Jeong I, Chun JH, Lee S. The prevalence of dementia in a metropolitan city of South Korea. *Int J Geriatr Psychiatry*. 2003;18:617–622.
- Koizumi J, Shiraishi H, Ofuku K, Suzuki T. Duration of delirium shortened by the correction of electrolyte imbalance. *Jpn J Psychiatry Neurol*. 1988;42:81–88.
- Kolbeinson H, Jonsson A. Delirium and dementia in acute medical admissions of elderly patients in Iceland. *Acta Psychiatr Scand*. 1993;87:123–127.
- Koponen H, Stenback U, Mattila E, Soininen H, Reinikainen K, Riekkinen PJ. Delirium among elderly persons admitted to a psychiatric hospital: clinical course during the acute stage and one-year follow-up. *Acta Psychiatr Scand*. 1989;79:579–585.
- Kua EH. The prevalence of dementia in elderly Chinese. *Acta Psychiatr Scand*. 1991;83:350–352.
- Kua EH, Ko SM. Prevalence of dementia among elderly Chinese and Malay residents of Singapore. *Int Psychogeriatr*. 1995;7:439–446.
- Lipowski ZJ. Delirium in the elderly patient. *N Engl J Med*. 1989;320:578–582.
- Marcantonio ER, Flacker JM, Michaels M, Resnick NM. Delirium is independently associated with poor functional recovery after hip fracture. *J Am Geriatr Soc*. 2000;48:618–624.
- McAvay GJ, Van Ness PH, Bogardus ST Jr, Zhang Y, Leslie DL, Leo-Summers LS, Inouye SK. Older adults discharged from the hospital with delirium: 1-year outcomes. *J Am Geriatr Soc*. 2006;54:1245–1250.

32. McCusker J, Cole M, Dendukuri N, Han L, Belzile E. The course of delirium in older medical inpatients: a prospective study. *J Gen Intern Med*. 2003;18:696–704.
33. Mullen JO, Mullen NL. Hip fracture mortality: a prospective, multifactorial study to predict and minimize death risk. *Clin Orthop Relat Res*. 1992;280:214–222.
34. Mungas D. In-office mental status testing: a practical guide. *Geriatrics*. 1991;46:54–58, 63, 66.
35. Owens WD, Felts JA, Spitznagel EL Jr. ASA physical status classifications: a study of consistency of ratings. *Anesthesiology*. 1978;49:239–243.
36. Plum F. Dementia: an approaching epidemic. *Nature*. 1979;279:372–373.
37. Robertson BD, Robertson TJ. Postoperative delirium after hip fracture. *J Bone Joint Surg Am*. 2006;88:2060–2068.
38. Rockwood K. Acute confusion in elderly medical patients. *J Am Geriatr Soc*. 1989;37:150–154.
39. Rockwood K. The occurrence and duration of symptoms in elderly patients with delirium. *J Gerontol*. 1993;48:M162–M166.
40. Rudberg MA, Pompei P, Foreman MD, Ross RE, Cassel CK. The natural history of delirium in older hospitalized patients: a syndrome of heterogeneity. *Age Ageing*. 1997;26:169–174.
41. Sahadevan S, Saw SM, Gao W, Tan LC, Chin JJ, Hong CY, Venketasubramanian N. Ethnic differences in Singapore's dementia prevalence: the stroke, Parkinson's disease, epilepsy, and dementia in Singapore study. *J Am Geriatr Soc*. 2008;56:2061–2068.
42. Schwartz TL, Masand PS. The role of atypical antipsychotics in the treatment of delirium. *Psychosomatics*. 2002;43:171–174.
43. Sirois F. Delirium: 100 cases. *Can J Psychiatry*. 1988;33:375–378.
44. Winawer N. Postoperative delirium. *Med Clin North Am*. 2001;85:1229–1239.