# Risk factors for postoperative delirium and subsyndromal delirium in older surgical patients in the surgical ward: a prospective observational study

**Maya Kanno** (mkan@yokohama-cu.ac.jp)
Yokohama Shiritsu Daigaku https://orcid.org/0000-0003-1180-3768
**Mana Doi**
Yokohama Shiritsu Daigaku
**Kazumi Kubota**
Yokohama Shiritsu Daigaku
**Yuka Kanoya**
Yokohama Shiritsu Daigaku

---

**Research article**

**Keywords:** Delirium, Subsyndromal delirium, Surgical ward, Aged, Inpatients, General surgery, Acute hospital, Confusion Assessment Method

**Posted Date:** November 20th, 2020

**DOI:** https://doi.org/10.21203/rs.3.rs-44194/v2



---

**Version of Record:** A version of this preprint was published at PLOS ONE on August 2nd, 2021. See the published version at https://doi.org/10.1371/journal.pone.0255607.

# Abstract

**Background:** Postoperative delirium (POD) among older patients is a common, serious disease and is associated with a high incidence of negative outcomes. For early detection of POD and subsyndromal delirium (SSD), this study was conducted to identify risk factors of POD and SSD in older patients who were scheduled for surgery in a surgical ward.

**Methods:** This was a prospective observational study. Study participants were older than 65 years, underwent urology surgery, and were hospitalized in the surgical ward between April and September 2019. Both POD and SSD were assessed by using the Confusion Assessment Method (CAM) on the preoperative day, the day of surgery, and postoperative days 1–3 by the surgical ward nurses. SSD was defined as the presence of one or more CAM criteria and the absence of a diagnosis of delirium based on the CAM algorithm. Personal characteristics, clinical data, cognitive function, physical functions, laboratory test results, medication use, type of surgery and anesthesia, and use of physical restraint were collected from medical records. Logistic regression analyses were conducted to identify the risk factors for POD and SSD.

**Results:** A total of 101 participants (mean age 74.9 years) were enrolled; 19 (18.8%) developed POD and SSD. The use of bed sensors (odds ratio 10.2, $p$=.001) were identified as risk factors for POD and SSD.

**Conclusions:** Our study shows that the use of bed sensors might be related to the development of POD and SSD among older patients in surgical wards.


# Background

Delirium is a common and serious condition among older patients. Older age and surgery are risk factors for delirium [1, 2]. The incidence of postoperative delirium (POD) in the older population ranges from 11% to 51% [2], and is associated with many negative outcomes, including the high risk of complications, cognitive decline, prolonged hospital stay, rehospitalization, institutionalization, and mortality [2-4]. Therefore, early detection of POD among older patients and appropriate care is important to prevent the worsening of POD and the associated complications.

Subsyndromal delirium (SSD) is an important predictor of POD. SSD is characterized by the presence of certain symptoms of delirium without the full symptoms, and it is likely to develop into POD [5, 6]. Furthermore, SSD in older patients is associated with many negative outcomes as well as POD, including a decline in activities of daily living (ADL), prolonged hospital stay, and high mortality [5-8]. Therefore, the identification of older patients at risk for SSD is important.

For POD, altered cognitive state [9, 10], impaired personal activities of daily living (ADL) [9], and anxiety [11] are some of the many risk factors. These factors are important aspects for assessing of the living function in older adults. In contrast, only three risk factors for SSD have been identified in the surgical ward in previous studies: higher pain level, a recent history of falls within the past 6 months, and a longer preoperative fasting time [12, 13]. We predicted that there are more risk factors of SSD, similar to POD, such as cognitive state, ADL, and anxiety. Thus, the risk factors of SSD in older patients admitted to the surgical ward need to be widely investigated. In addition, we need to understand both risk factors of POD and SSD because POD and SSD are continuous concept [7]. Therefore, the aim of this study was to identify both risk factors of POD and SSD in older patients who underwent surgery and were admitted postoperatively in the surgical ward.

# Methods

## Study design and participants

This was a prospective observational study. This single-center study recruited older patients (>65 years) who underwent surgery, under general or spinal anesthesia, for urological diseases and were postoperatively treated in the surgical ward of a tertiary care hospital in a metropolitan area of Japan between April 2019 and September 2019. Eligible patients were enrolled if they provided consent for study participation. The exclusion criteria were: (1) ICU admission, (2) low level of consciousness before the surgery (Japan Coma Scale 100–300), (3) inability to speak Japanese, (4) impaired judgment because of developmental disorders or cognitive decline, and (5) preoperative onset of delirium. Participants with missing data for the dependent variables were excluded from the analysis.

## Study procedures

The ward nurses assessed all patients for POD and SSD for five days—the day before the surgery, the day of the surgery, and three consecutive days post-surgery—using the Japanese version of the Confusion Assessment Method (CAM), which was developed from the diagnostic criteria specified in the Diagnostic and Statistical Manual of Mental Disorders-□ [14], which enabled easy screening for delirium. We defined the assessment periods in this study based on prior studies [15]. On the day before the surgery, the CAM was applied once during the day shift (from hospitalization until 17:00). Postoperatively, patient evaluation with the CAM was undertaken three times in a day, once during each shift (9:00 to 17:00, 17:00 to 1:00, and 1:00 to 9:00). The ward nurses received training that imparted basic knowledge on the identification of postoperative delirium and learned how to use the CAM to ensure consistency in the assessments by a researcher. The training was designed to minimize the burden on the ward nurses with reference to the Short CAM Training Manual [16], as well as a previous study [17], and included: (1) the presentation, (2) a SHORT CAM POST-TEST in accordance with the instructions in the Short CAM Training Manual, and (3) an assessment for delirium in three situations, provided by a case presentation video and discussion.

## Measurement of study variables

### *Outcomes: the incidence of POD and SSD*

We specified the incidence of both POD and SSD as outcomes because episodes of SSD are closely related to POD [5, 6]. Patients were evaluated for both POD and SSD by using the CAM, which comprises four criteria: (1) acute onset and fluctuating course, (2) inattention, (3) disorganized thinking, and (4) altered level of consciousness. The CAM algorithm for the diagnosis of delirium requires the presence of both the first and the second criteria and of either the third or the fourth criteria [18]. In this study, POD was defined by the diagnosis of delirium based on the CAM algorithm. The SSD was defined as the presence of one or more CAM criteria and the absence of a diagnosis of delirium based on the CAM algorithm [6, 9, 19, 20]. The CAM can be completed in less than 5 minutes [21], and the Japanese version of the CAM has high sensitivity (83.3%) and high specificity (97.6%) when validated for use by nurses compared with psychiatrists [22]. We obtained permission for the use of the Japanese version of CAM from the copyright holder (Hospital Elder Life Program) and the developer (Akira Watanabe).

### *Demographic characteristics and surgical clinical variables*

The demographic characteristics and surgical clinical variables were defined as independent variables, and the Comprehensive Geriatric Assessment-short version (CGA7) was set as the key independent variable. We obtained age, sex, ADL-function, comorbidity, history of dementia and cerebrovascular disease, medication use, emergency admission, visual and hearing disabilities, the degree of dementia and care need, and the score from the CGA7 at the baseline. The use of physical restraint, and bed sensors were examined for the day of surgery and all three days after surgery. We evaluated physical restraint and bed sensors separately. Physical restraint refers to the use of devices to immobilize someone or restrict a person's ability to move part of their body freely [23], including belts, ropes, and mittens. In constract, bed sensors are pressure sensors built into the mattress, which relay on-off signals to the nursing call bell system. Timing of alert by bed sensors can be changed for each activity, such as getting up, sitting on the bed, and getting out of bed. We gathered the lesion site, operative method, anesthesia type, operative duration, intraoperative blood loss, preoperative and postoperative results of laboratory blood tests [white blood cell (WBC), red blood cell (RBC), hemoglobin (Hb), hematocrit (Ht), platelet (Plt), total protein (TP), albumin (Alb), blood urea nitrogen (BUN), creatinine (Cr), sodium (Na), potassium (K), chlorine (Cl), calcium (Ca), and C-reactive protein (CRP)], the use of narcotic analgesics, and the number of days that the patient's regular medication was interrupted postoperatively as surgical clinical variables that were recorded on all five days.

ADL was assessed using the Barthel Index which is an objective scale to evaluate the ADL with scores ranging from 0 to 100; increasing score indicates greater independence [24]. Comorbidity was assessed using the Charlson Comorbidity Index (CCI), which is a severity classification scoring tool for comorbidities (0 to 37); increasing score indicates worse illness [25]. Both of these tools have good reliability and validity.

The degree of dementia and care need was assessed by Independence degree of daily living for the elderly people with dementia and the stage of long-term care need are the assessments of the appropriate care requirements of older adults and that have been developed by the Ministry of Health, Labour and

Welfare of Japan. Independence degree of daily living for the elderly people with dementia has five levels: □, □, □, □, and M, with M indicating maximum dependence. The stage of long-term care need has seven levels: support needed (1 and 2) and care needed (1 to 5); care needed 5 indicates maximum dependence.

The CGA7 is a screening tool taht extracted seven key items from a total of 40 items in four validated scales: Barthel Index, revised version of Hasegawa's Dementia Scale, Vitality Index, and Geriatric Depression Scale [26]. The CGA7 assesses on aspects in the geriatric physical, psychological, and social domains. The CGA7 comprises of the following questions: CGA1 (motivation): "Can the subject greet the examiner by himself/herself?", CGA2 (cognitive function): "Can the subject repeat 'cherry blossoms, cats, trains'?," CGA3 (instrumental ADL): "Can the subject go to the hospital by himself/herself?," CGA4 (cognitive function): "Can the subject recall three words in CGA2 and repeat that?," CGA5 (ADL): "Can the subject take a bath by himself/herself?," CGA6 (ADL): Can the subject use the toilet by himself/herself?," and CGA7 (emotion/mood): "Does the subject feel he/she is powerless?"). The CGA7 is assessed with "can"/"yes" or "cannot"/"no" for each question; negative outcomes on the CGA7 indicate older adults have low living function. The specific assessment of the reliability and validity of the CGA7 test was deemed unnecessary because all four scales from which the tool was compiled have good reliability and validity.

### Statistical analyses

#### *Samples size estimation*

In the primary analysis of this study, we specified the key independent variables from the CGA7, which comprised seven items. To calculate the sample size, the smaller incidence rates in the number of patients developing POD and SSD and those who did not develop POD and SSD require at least 6 to 10 patients per independent variable for logistic regression analysis [27]. A prior study reported POD and SSD incident rates to be 58.1% among older patients undergoing surgery [6]. Thus, we calculated that a minimum of 100 participants were required for the primary analysis

#### *Outcome analyses*

Continuous variables with normal distribution were analyzed using the Student's t-test. Continuous variables with abnormal distribution or ordinal data were analyzed using the Mann-Whitney U test. Categorical variables were analyzed using the Chi-squared test or Fisher exact test. We conducted logistic regression analysis (Forward Selection: Likelihood Ratio) with POD and SSD as the dependent variables. The primary analysis was carried out with the key independent variables in the CGA7. The secondary analysis incorporated the CGA7 and the related variables of the POD and SSD. Before the logistic regression analysis, data were analyzed by univariate analysis to identify the factors related to POD and SSD. Variables with a *p*-value <0.2 on the univariate analysis were included in the secondary analysis. All data were analyzed in SPSS statistics version 26 and the significance level was set at $p<0.05$.

## Results

### Study population

A total of 121 participants were recruited; of these, 20 were excluded and 101 participants were included in the final analysis (Fig. 1). The demographic characteristics and surgical clinical variables of participants are shown in Tables 1 and 2. The mean age of patients in this study population was 74.9 (6.2) years, and the majority were male (66.3%) and independent. The mean CCI score was 2.3 (1.1). Most participants had no dementia (98.0%) and underwent transurethral resection (60.4%), under general anesthesia (92.1%). The mean Barthel Index score was 97.7 (9.9). A few participants had a negative on the CGA7 (8.9%).

Figure 1. Patient enrollment flowchart

### Association between indicators and POD and SSDby univariate analysis

A total of 19 participants were postoperatively observed for POD and SSD by CAM (POD, n=3; SSD, n=16). Both POD and SSD were significantly associated with high score of CCI ($p$=0.023), Emergency admission ($p$=0.034), low independence degree of daily living for the elderly people with dementia ($p$=0.006), many medications ($p$=0.016), preoperative high CRP ($p$=0.030), physical restraint use ($p$=0.034), and bed sensor use ($p$=0.001) on the univariate analysis (Tables 1 and 2).

### Risk factors of POD and SSD by logistic regression analysis

First, we conducted a primary analysis by the logistic regression analysis, which included the key independent variables. The model did not work out due to the separation variables, which is an issue in the logistic regression analysis [28].

Second, we included the CGA7 as a key independent variable along with eight independent variables for the logistic regression analysis (e.g., CCI, medication use, preoperative WBC, preoperative Na, preoperative Cl, preoperative CRP, operative duration, and bed sensor use), which showed correlations on univariate analysis ($p$-value <0.2). Logistic regression analysis showed that POD and SSD were associated with bed sensor use [odds ratio (OR) 10.2; $p$=0.001, 95% confidence interval (CI) 2.68–38.65] (Table 3).

## Discussion

Our study showed that POD and SSD among older patients in the surgical ward are related to bed sensor use.

In this study, the incidence of POD and SSD was 18.8%, compared to the 58.1–67.9% that was reported previously [6, 12, 13]. Moreover, in this study, the incidence of POD was 3.0%, compared to the 11%–51% that was reported previously [2]. The incidence of POD and SSD was remarkably low in comparison to previous studies. Four reasons may account for this difference. First, it may due to the remarkable few patients with dementia. Out of 101 participants, only two patients had dementia. Dementia is a risk factor of POD [10] and SSD [29, 30]. As a result, patients with dementia were excluded in this study. It may have affected the incidence rate of POD and SSD in this study population. Second, our study participants had a high level of independence. Low ADL is a risk factor for SSD [9, 31]. Thus, high ADL caused a lower incidence of POD and SSD. Third, there might have been a selection bias of the surgical patients. Since low-performance status and high comorbidity are likely to reduce patients' overall survival after surgery, healthcare providers might have preferentially selected healthy older patients for safe surgery [32]. Also, these patients underwent a minimally invasive surgery. Transurethral resection constituted 60.4% of the surgeries and abdominal surgery was not included in this study. This may have affected the incidence of POD and SSD. Finally, POD and SSD was assessed by nurses; hence, the sensitivity might be low in this study because CAM assessments by nurses might be poorly specified [33]. The surgical ward nurses were trained on basic knowledge of delirium and the use of CAM; however, it might have been insufficient for the research purpose.

Furthermore, the logistic regression analysis suggested that bed sensor use was associated with an increased risk of POD and SSD. We attributed two reasons for this. The first reason is the intentional bed sensor use by nurses. Bed sensors are usually used for patients with dementia and poor ADL to prevent fall [34]. Despite no sign of altered cognitive state and impaired ADL in baseline, we predicted that nurses expected these signs of them from postoperative assessment and intentionally used bed sensors. In addition, frail older patients were likely to change their rooms near the nurse station. Room transfer is a risk factor for delirium amongst older patients [35]. Moreover, there is a possibility that nurses used bed sensors only at night to prevent falls because of darkness, which suggests that night-time investigations may be associated with increased delirium incidence [36]. These elements would be potential confounders of the association between the use of bed sensor and the development of POD and SSD. The second reason is that using a bed sensor is considered a restraint, since it restricts the free movements of older patients to prevent fall. Physical restraint, defined as something that restricts a person’s ability to move freely [23], is a risk factor for POD [37]. Using bed sensors might increase the risk of POD and SSD.

This study has several limitations. First, there was a low incidence of POD and SSD in contrast to the expectation because most of the participants were healthy, and we consequently excluded patients with dementia who have a high risk of POD and SSD. In effect, we missed potential risk factors. Second, the influence of nursing care could not be evaluated. Good nursing care might affect the incidence of POD and SSD and other risk factors and suppress the relationship between such factors and the study outcomes. Third, we did not assess cognitive functions during CAM assessment to concern the burden of older patients because the cognitive scale requires the patient’s independent work. CAM should be scored based on a formal cognitive evaluation to distinguish delirium and dementia because of similarity. Thus, there was a possibility that participants with dementia were identified as POD and SSD. This might have affected the incidence rate of POD and SSD. However, despite these limitations, this study provides a knowledge base for the evaluation of POD and SSD in older patients in the surgical ward for future studies. Future studies are needed to assess and adjust for relevant confounders of the relationship between “bed sensor use” and thus confirm relevant risk factors for POD and SSD.

In conclusion, our study shows that the use of bed sensors might be related to the development of POD and SSD among older patients in surgical wards.

# Declarations

- Ethics approval and consent to participate: This study was approved by the Institutional Review Board of the Medical Department of the Yokohama City University on April 1, 2019 (approval no. B190200026). All participants provided formal written informed consent prior to study participation.
- Consent for publication: Not applicable
- Availability of data and materials: The datasets generated and/or analyzed during the current study are not publicly available to protect patient privacy.
- Competing interests: The authors declare that they have no competing interests.
- Funding: Not applicable
- Authors' contributions: All authors read and approved the final manuscript and meet the journal's criteria of authorship. MK, MD, KK and YK: Design. MK: data collection. MK, MD, KK and YK: analysis. MK, MD, KK and YK: manuscript preparation.
- Acknowledgements: Not applicable

# Abbreviations

ADL, activities of daily living; POD, postoperative delirium; SSD, subsyndromal delirium; CAM, Confusion Assessment Method; OR, odds ratio, CI, confidence interval; WBC, white blood cell; RBC, red blood cell; Hb, hemoglobin; Ht, hematocrit; Plt, platelet; TP, total protein; Alb, albumin; BUN, blood urea nitrogen; Cr, creatinine; Na, sodium; K, potassium; Cl, chlorine; Ca, calcium; CRP, C-reactive protein

# References

1. Michaud L, Büla C, Berney A, Camus V, Voellinger R, Stiefel F, et al; Delirium Guidelines Development Group. Delirium: guidelines for general hospitals. J Psychosom Res. 2007;62:371-83
2. Inouye SK, Westendorp RG, Saczynski JS, Kimchi EY, Cleinman AA. Delirium in elderly people–authors'reply. Lancet. 2014;383:2045.
3. Saxena S, Lawley D. Delirium in the elderly: a clinical review. Postgrad Med J 2009;85:405-13.
4. Martins S, Fernandes L. Delirium in elderly people: a review. Front Neurol. 2012;3:101.
5. Marcantonio ER, Kiely DK, Simon SE, John Orav E, Jones RN, Murphy KM, et al. Outcomes of older people admitted to postacute facilities with delirium. J Am Geriatr Soc. 2005;53:963-9.

6. Shim J, DePalma G, Sands LP, Leung JM. Prognostic Significance of Postoperative Subsyndromal Delirium. Psychosomatics. 2015;56:644-51.
7. Ouimet S, Riker R, Bergeron N, Cossette M, Kavanagh B, Skrobik Y et al. Subsyndromal delirium in the ICU: evidence for a disease spectrum. Intensive Care Med. 2007;33:1007-13.
8. Brummel NE, Boehm LM, Girard TD, Pandharipande PP, Jackson JC, Hughes CG et al. Subsyndromal delirium and institutionalization among patients with critical illness. Am J Crit Care. 2017;26:447-55.
9. Velilla NM, Bouzon CA, Contin KC, Beroiz BI, Herrero AC, Renedo JA. Different functional outcomes in patients with delirium and subsyndromal delirium one month after hospital discharge. Dement Geriatr Cogn Disord. 2012;34:332-6.
10. Wu Y, Shi Z, Wang M, Zhu Y, Li C, Li G, et al. Different MMSE score is associated with postoperative delirium in young-old and old-old adults. PLoS One. 2015;10:e0139879.
11. Van Grootven B, Detroyer E, Devriendt E, Sermon A, Deschodt M, Flamaing J, et al. Is preoperative state anxiety a risk factor for postoperative delirium among elderly hip fracture patients? Geriatr Gerontol Int. 2016;16:948-55.
12. Denny DL, Lindseth G. Preoperative risk factors for subsyndromal delirium in older adults who undergo joint replacement surgery. Orthop Nurs. 2017;36:402-11.
13. Denny DL, Lindseth GN. Pain, opioid intake, and delirium symptoms in adults following joint replacement surgery. West J Nurs Res. 2020;42:165-76.
14. American Psychiatric Association. Task Force on Nomenclature and Statistics APACoNaS. Diagnostic and statistical manual of mental disorders. 3rd ed. Washington, DC: American Psychiatric Association; 1980.
15. Hattori H, Kamiya J, Shimada H, Akiyama H, Yasui A, Kuroiwa K, et al. Assessment of the risk of postoperative delirium in elderly patients using E-PASS and the NEECHAM Confusion Scale. Int J Geriatr Psychiatry. 2009;24:1304-10.
16. The Short Confusion Assessment Method (Short CAM) Training Manual and Coding Guide http://www.hospitalelderlifeprogram.org/uploads/disclaimers/Short_CAM_Training_Manual_8-29-14.pdf. Accessed 4 September, 2018.
17. Lemiengre J, Nelis T, Joosten E, Braes T, Foreman M, Gastmans C,et al. Detection of delirium by bedside nurses using the confusion assessment method. J Am Geriatr Soc. 2006;54:685-9.
18. 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.
19. Li HC, Chen YS, Chiu MJ, Fu MC, Huang GH, Chen CC. Delirium, subsyndromal delirium, and cognitive changes in individuals undergoing elective coronary artery bypass graft surgery. J Cardiovasc Nurs. 2015;30:340-5.
20. Diwell RA, Davis DH, Vickerstaff V, Sampson EL. Key components of the delirium syndrome and mortality: greater impact of acute change and disorganised thinking in a prospective cohort study. BMC Geriatr. 2018;18:24.

21. Grover S, Kate N. Assessment scales for delirium: A review. World J Psychiatry. 2012;2:58-70.
22. Watanabe A. The Confusion Assessment Method: Validation of Japanese-Language version. Japanese Journal of General Hospital Psychiatry. 2013;25:165-70. [in Japanese]
23. Strategies to end seclusion and restraint: WHO QualityRights Specialized training: course slides https://apps.who.int/iris/handle/10665/329747. Accessed 23 June, 2020.
24. Mahoney FI, Barthel DW. Functional evaluation: The Barthel Index. Md State Med J. 1965;14:61-5.
25. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Clin Epidemiol. 1987;40:373-83.
26. Toba K. The guideline for comprehensive geriatric assessment. Japanese Journal of Geriatrics. 2005;42:177-80. [in Japanese]
27. Peduzzi P, Concato J, Kemper E, Holford TR, Feinstein AR. A simulation study of the number of events per variable in logistic regression analysis. J Clin Epidemiol. 1996;49:1373-9.
28. Zeng G, Zeng E: On the relationship between multicollinearity and separation in logistic regression. Communications in Statistics - Simulation and Computation 2019;1-9.
29. Ryan DJ, O'Regan NA, Caoimh R, Clare J, O'Connor M, Leonard M, *et al*. Delirium in an adult acute hospital population: predictors, prevalence and detection. BMJ Open. 2013; 3(1).
30. Lam CY, Tay L, Chan M, Ding YY, Chong MS. Prospective observational study of delirium recovery trajectories and associated short-term outcomes in older adults admitted to a specialized delirium unit. J Am Geriatr Soc. 2014;62(9):1649-57.
31. Marcantonio E, Ta T, Duthie E, Resnick NM. Delirium severity and psychomotor types: their relationship with outcomes after hip fracture repair. J Am Geriatr Soc. 2002;50:850-7.
32. Bolenz C, Ho R, Nuss GR, Ortiz N, Raj GV, Sagalowsky AI, et al. Management of elderly patients with urothelial carcinoma of the bladder: guideline concordance and predictors of overall survival. BJU Int. 2010;106(9):1324-9.
33. Wei LA, Fearing MA, Sternberg EJ, Inouye SK. The Confusion Assessment Method: a systematic review of current usage. J Am Geriatr Soc. 2008;56(5):823-30.
34. Kwok T, Mok F, Chien WT, Tam E. Does access to bed-chair pressure sensors reduce physical restraint use in the rehabilitative care setting? J Clin Nurs. 2006;15(5):581-7.
35. Goldberg A, Straus SE, Hamid JS, Wong CL. Room transfers and the risk of delirium incidence amongst hospitalized elderly medical patients: a case-control study. BMC Geriatr. 2015;15:69.
36. Evensen S, Saltvedt I, Lydersen S, Wyller TB, Taraldsen K, Sletvold O. Environmental factors and risk of delirium in geriatric patients: an observational study. BMC Geriatr. 2018;18(1):282.
37. Chen H, Jiang H, Chen B, Fan L, Shi W, Jin Y, et al. The Incidence and Predictors of Postoperative Delirium After Brain Tumor Resection in Adults: A Cross-Sectional Survey. World Neurosurg. 2020; doi:10.1016/j.wneu.2020.04.195.

# Tables

Table 1. Demographic characteristics

| Variables | Total, n=101 | CAM delirium status | | p-value |
|---|---|---|---|---|
| | | No delirium, n=82 | POD and SSD, n=19 | |
| Age (years)[a], mean (SD) | 74.9 (6.2) | 74.8 (6.9) | 75.7 (6.9) | 0.623 |
| Men[b], n (%) | 67 (66.3) | 51 (62.2) | 16 (84.2) | 0.439 |
| Barthel Index[a], mean (SD) | 97.7 (9.9) | 98.1 (9.1) | 94.4 (16.0) | 0.329 |
| CCI[a], mean (SD) | 2.3 (1.1) | 2.2 (1.1) | 2.8 (1.4) | 0.023** |
| Dementia[b], n (%) | 2 (2.0) | 0 (0) | 2 (10.5) | 0.034** |
| Cerebrovascular disease[b], n (%) | 6 (5.9) | 4 (4.9) | 2 (10.5) | 0.315 |
| Emergency admission[b], n (%) | 2 (2.0) | 0 (0) | 2 (10.5) | 0.034** |
| Number of medications[a], mean (SD) | 4.1 (4.0) | 3.7 (4.5) | 5.8 (30.5) | 0.016** |
| Anticholinergic drug use[b], n (%) | 5 (5.0) | 3 (3.7) | 2 (10.5) | 0.236 |
| Diazepam conversion (regular drugs)[a], mean (SD) | 0.8 (2.2) | 0.7 (2.0) | 1.2 (3.2) | 0.520 |
| Non-visual disorder[b], n (%) | 16 (15.8) | 12 (14.6) | 4 (21.1) | 0.495 |
| Non-hearing disorder, n (%) | 71 (70.3) | 59 (72.0) | 12 (63.2) | 0.655 |
| Independence daily living for the elderly people with dementia [b], n (%) | 98 (97.0) | 82 (100.0) | 16 (84.2) | 0.006** |
| Independence long-term care need[b], n (%) | 94 (93.1) | 76 (92.7) | 18 (94.7) | 0.643 |
| Negative outcome in CGA7, n (%) | 9 (8.9) | 6 (7.3) | 3 (15.8) | 0.36 |
| (1) | 1 (1.0) | 1 (1.2) | 0 (0) | 1.00 |
| (2) | 1 (1.0) | 1 (1.2) | 0 (0) | 1.00 |
| (3) | 5 (5.0) | 3 (3.7) | 2 (10.5) | 0.24 |
| (4) | 1 (1.0) | 1 (1.2) | 0 (0) | 1.00 |
| (5) | 5 (5.0) | 3 (3.7) | 2 (10.5) | 0.24 |
| (6) | 1 (1.0) | 0 (0) | 1 (5.3) | 0.19* |
| (7) | 3 (3.0) | 2 (2.4) | 1 (5.3) | 0.47 |
| Use of physical restraint[b] | 2 (2.0) | 0 (0) | 2 (10.5) | 0.034** |
| Bed sensor use[b] | 12 (11.9) | 5 (6.1) | 7 (36.8) | 0.001** |

Note. SD, standard deviation; CCI, Charlson Comorbidity Index; CGA7, Comprehensive Geriatric Assessment-short version.

n the subject greet the examiner by himself/herself?

n the subject repeat 'cherry blossoms, cats, trains'?

n the subject go to the hospital by himself/herself?

n the subject recall three words in CGA2 and talk that?

n the subject take a bath by himself/herself?

n the subject use the toilet by himself/herself?

es the subject feel he/she is powerless?

Continuous variables were analyzed by the Student's *t*-test or [a]Mann–Whitney *U* test.
Categorical variables were analyzed by the chi-square test or [b]Fisher's exact test.
*P*-values significant at the 20% and 5% levels are shown as *, $p<0.2$ and **, $p<0.05$.

Table 2. Surgical clinical variables

| Variables | Total, n=101 | CAM delirium status | | *p*-value |
|---|---|---|---|---|
| | | No delirium, n=82 | POD and SSD, n=19 | |
| Lesion site[b], n (%) | | | | |
| Kidney tumor | 10 (9.9) | 8 (9.8) | 2 (10.5) | |
| Bladder cancer | 50 (49.5) | 42 (51.2) | 8(42.1) | |
| Prostatic cancer | 16 (15.8) | 12 (14.6) | 4(21.1) | |
| Benign prostatic hypertrophy | 13 (12.9) | 9 (11.0) | 4(21.1) | |
| Others | 12 (11.9) | 11 (13.4) | 1(5.3) | 0.601 |
| Operative methods[b], n (%) | | | | |
| Laparoscopic surgery | 29 (28.7) | 24 (29.3) | 5 (26.3) | |
| Transurethral resection | 61 (60.4) | 50 (61.0) | 11 (57.9) | |
| Others | 11 (10.9) | 8 (9.8) | 3 (15.8) | 0.668 |
| Anesthesia[b], n (%) | | | | |
| General anesthesia | 93 (92.1) | 74 (90.2) | 19 (100.0) | |
| Spinal anesthesia | 8 (7.9) | 8 (9.8) | 0 (0) | 0.346 |
| Results of preoperative blood tests, mean (SD) | | | | |
| WBC ($10^3/\mu L$)[a] | 6.3 (1.8) | 6.1 (1.6) | 7.1 (2.5) | 0.141* |
| Hb (g/dL)[a] | 12.3 (1.8) | 13.4 (1.8) | 13.0 (2.1) | 0.546 |
| Cr (mg/dL)[a] | 1.0 (0.6) | 1.0 (0.6) | 1.2 (0.6) | 0.279 |
| Na (mmol/L)[a] | 141.5 (2.4) | 141.8 (2.2) | 140.3 (2.8) | 0.056* |
| K (mmol/L)[a] | 4.3 (0.4) | 4.3 (0.4) | 4.4 (0.4) | 0.426 |
| Cl (mmol/L) | 104.6 (2.5) | 104.8 (2.5) | 103.6 (2.6) | 0.058* |
| Ca (mmol/L) | 9.4 (0.4) | 9.4 (0.4) | 9.5 (0.5) | 0.305 |
| CRP (mg/L)[a] | 0.5 (1.9) | 0.3 (0.5) | 1.8 (4.0) | 0.030** |
| Operative duration (min)[a], mean (SD) | 119.7 (112.4) | 116.0 (113.7) | 141.1 (113.7) | 0.088* |
| Intraoperative blood loss (mL)[a], mean (SD) | 87.9 (87.0) | 95.0 (234.0) | 55.3 (146.1) | 0.847 |
| Use of narcotic analgesics, n (%) | 28 (27.7) | 22 (26.8) | 6 (31.6) | 0.777 |
| Postoperative physical status, n (%) | | | | |
| Inflammation[b] | 2 ( 2.0) | 1 (1.2) | 1 (5.3) | 0.342 |
| Anemia | 27 (26.7) | 20 (24.4) | 7 (36.8) | 0.269 |
| Undernutrition | 28 (27.7) | 21 (25.6) | 7 (36.8) | 0.395 |
| Electrolyte abnormality[b] | 11 (10.9) | 11 (13.4) | 0 (0) | 0.119* |
| Decline in renal function[b] | 18 (17.8) | 13 (15.9) | 5 (26.3) | 0.322 |
| Postoperative use of sleeping pills[b], n (%) | 8 (7.9) | 6 (7.3) | 2 (10.5) | 0.643 |

Note. SD, standard deviation.

Continuous variables were analyzed by the Student's *t*-test or [a]Mann–Whitney *U* test.

Categorical variables were analyzed by the chi-square test or [b]Fisher's exact test.

*P*-values significant at the 20% and 5% levels are shown as *, $p<0.2$ and **, $p<0.05$.

Table 3. Risk factors of POD and SSD on logistic regression analysis

| Variables | β | SE | *p*-value | OR | 95% CI |
|---|---|---|---|---|---|
| Bed sensor use<br>No, 0; Yes, 1 | 2.321 | 0.681 | 0.001 | 10.18 | 2.682–38.652 |
| Preoperative CRP mg/dL | 0.388 | 0.202 | 0.054 | 1.47 | 0.993–2.188 |

Note. β, regression coefficient; SE, standard error; 95% CI, 95% confidence interval

## Figures

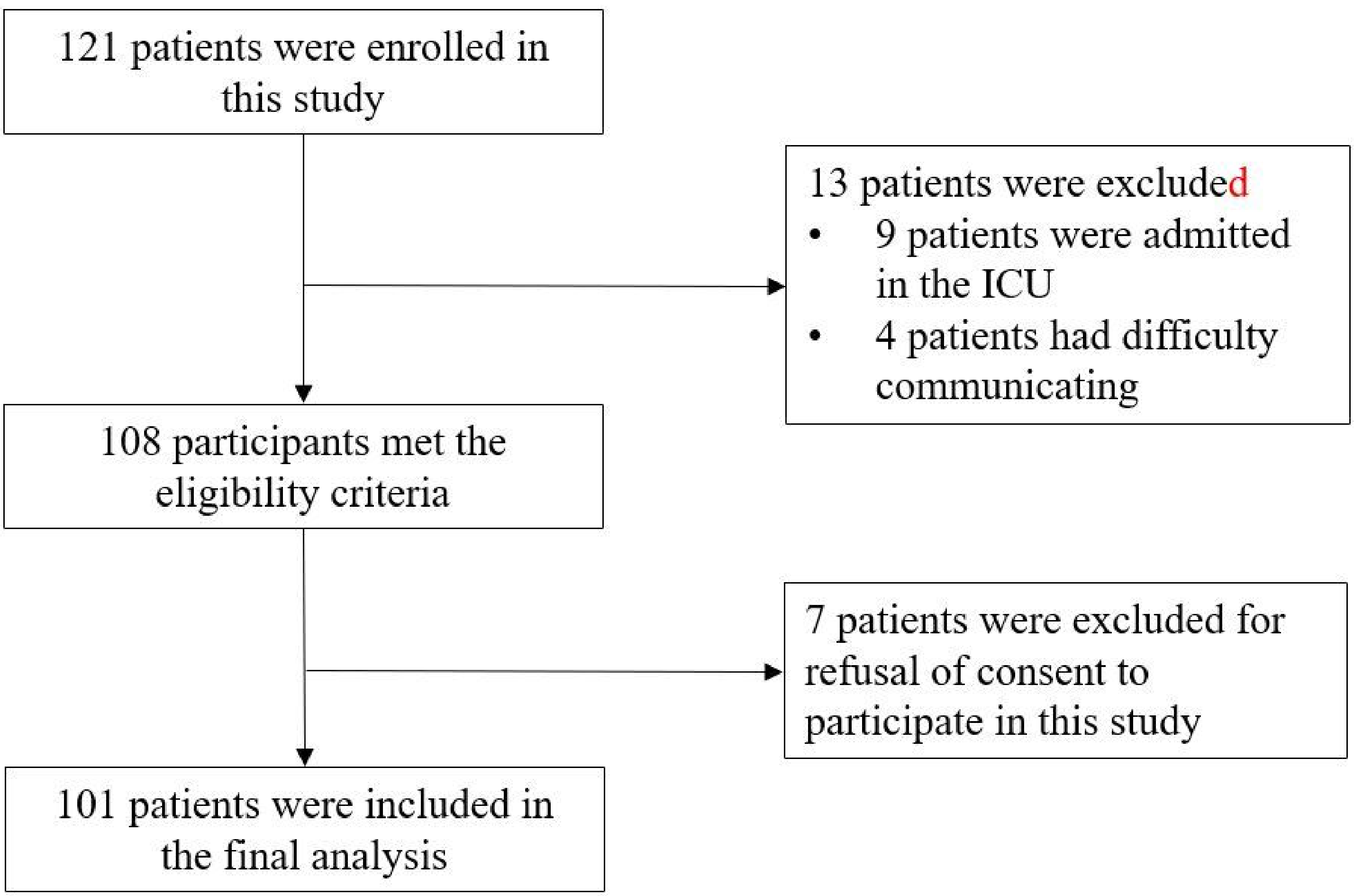


Figure 1

Patient enrollment flowchart