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# Frequency of postoperative delirium and associated factors among consultation-liaison psychiatry patients with schizophrenia spectrum disorders undergoing surgery: a retrospective cohort study

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**Patients with schizophrenia spectrum disorders (SSDs) have a high risk of physical illnesses that require surgery. Postoperative delirium (POD) is an important postoperative complication that may be difficult to manage in patients with SSDs and may require psychiatric expertise. This study aimed to investigate the frequency of POD and its associated factors among patients with SSDs who were referred to consultation-liaison psychiatry during surgical hospitalization. A retrospective study was conducted at three tertiary hospitals in Japan, including 200 patients with SSDs who underwent surgery between April 2017 and March 2022 and were referred to consultation-liaison psychiatry during their surgical hospitalization. Patients admitted due to psychiatric crises were excluded. Data on demographics, psychiatric history, surgical details, and POD development were collected. Statistical analysis included chi-square or Fisher's exact tests and logistic regression to identify factors associated with POD. POD occurred in 10.5% of patients with SSDs, and only one patient required transfer to a psychiatric ward. Most patients had schizophrenia (90.5%), and the mean age was 57.4 years. In the exploratory multivariable analysis, age ≥ 65 years and smoking before admission showed associations with POD. Antipsychotic medication use or dose was not associated with POD. Most POD cases in this consultation-liaison psychiatry cohort were managed with psychotropic drug adjustments. These findings suggest that POD in psychiatrically managed surgical patients with SSDs may often be manageable in general hospitals when psychiatric liaison expertise is available, although further studies are needed to determine generalizability to broader populations of surgical patients with SSDs.**

**Keywords** Postoperative delirium, Schizophrenia spectrum disorders, Associated factors, Psychiatric care, Perioperative management

Schizophrenia spectrum disorders (SSDs) constitute a group of psychiatric conditions characterized by disturbances in cognition, perception, affect, and behavior. At the core of this spectrum lies schizophrenia, a severe and chronic mental illness marked by a high rate of relapse and commonly associated with a broad array of

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symptoms and functional impairments[1–3]. It affects 1 in every 300 people (0.32%), with a total patient population of approximately 24 million worldwide[3]. Patients with schizophrenia are 2–3 times more likely to die early than the general population because of the high prevalence of various physical illnesses, including cardiovascular, metabolic, and infectious diseases[4], as well as reduced engagement in health maintenance practices including maintaining healthy eating habits, performing exercise, and avoiding smoking[5,6]. In addition, disparities in access to treatments for physical illnesses have been associated with higher mortality rates[7]. The life expectancy for patients with SSDs is still short compared to the general population, while the number and percentage of elderly people with SSDs has been increasing as the population ages[8], resulting in increased frequency of hospitalization for the treatment of physical illnesses in this population.

Additionally, patients with SSDs are at an increased risk of various potential illnesses, including heart disease[9]; stroke[10]; pancreatic, esophageal, and breast cancer[11]; perforated appendicitis[12]; and cataracts[13], which may require surgery. Postoperative delirium (POD) is a common disorder that may be accompanied by psychomotor agitation. Patients with SSDs have many factors associated with delirium, including a high prevalence of physical comorbidities, long-term exposure to psychotropic medications, reduced cognitive reserve, and indicators of frailty[14].

Such delirium in patients with SSDs can be difficult to treat outside the psychiatric ward[15]. Moreover, patients with SSDs are often receiving antipsychotics and benzodiazepine receptor agonists (BZRAs), including zolpidem, zopiclone, and eszopiclone, at admission and have more complex background factors than the general population; therefore, the treatment of delirium in a general ward often requires the expertise of a psychiatrist. However, there are very few studies that specifically report the frequency of delirium in patients with SSDs, rather than in the general psychiatric population and it remains unclear what proportion of patients with SSDs who develop POD require transfer to a psychiatric ward. A lack of epidemiological data on POD in patients with SSDs may impede the acceptance of such patients in hospitals without a psychiatric ward.

With the continued decline in the number of general hospitals with psychiatric beds in Japan[16], this problem is becoming increasingly serious, especially in regional cities, which means that hospitals without psychiatric wards need to increase their ability to manage POD in patients with SSDs. Therefore, this study investigated the frequency of and factors associated with POD among surgical patients with SSDs who were referred to consultation-liaison psychiatry, with the aim of improving access to medical care for this population. To our knowledge, few studies have specifically examined POD among surgical patients with SSDs, and even fewer have reported how often POD requires transfer to a psychiatric ward. By focusing on consultation-liaison psychiatry patients with SSDs undergoing surgery, this study provides clinically relevant information on the frequency, associated factors, and psychiatric management outcomes of POD in this understudied population.

## Methods

### Study setting and data sources

This study included patients from three tertiary care hospitals in urban Japan totaling 2395 beds. All three hospitals perform gastrointestinal, cardiovascular, respiratory, endocrine and breast, plastic, neurologic, orthopedic, and pediatric surgeries and include obstetrics and gynecology, ophthalmology, dermatology, urology, and otolaryngology departments. One hospital has a transplant surgery department. All three hospitals also have psychiatric wards and consultation-liaison teams including psychiatrists, nurses, and psychologists who provide psychosocial care to patients with comorbid mental and physical illnesses admitted to the general wards. All three institutions are core hospitals in the region and accept patients with SSDs requiring surgical treatment, regardless of the type of physical illness.

### Selection criteria and outcomes

The study included patients with SSDs who were admitted for surgical treatment at the three study hospitals between April 1, 2017 and March 31, 2022 and were referred to the consultation-liaison psychiatry team during surgical hospitalization. SSDs included schizophrenia, delusional disorder, brief psychotic disorder, schizophreniform disorder, schizoaffective disorder, substance-induced or drug-induced psychotic disorder, or psychotic disorder due to another medical condition diagnosed before admission by psychiatrists managing their regular psychiatric treatment based on the Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-5)[17]. The participants were consultation-liaison patients, who were admitted to the general ward for surgery and referred to the consultation-liaison team. Psychiatrists advised the surgeons regarding the management of the patients' psychiatric comorbidities. However, this study excluded patients with SSDs admitted because of worsening psychiatric symptoms, including suicide attempts, owing to unstable mental health before admission.

The main outcome of this study was the proportion of patients who developed POD. We also investigated the number of patients who required transfer to a psychiatric ward after developing POD.

### Clinical data collection

In this retrospective chart review, board-certified psychiatrists involved in consultation-liaison psychiatric practice reviewed all available care records, prescription records, and laboratory data. The reviewers collected the following patient data: sex, age, smoking status, type and dose of psychotropic medication, Charlson Comorbidity Index[18], and psychiatric diagnosis based on DSM-5 criteria[17]. Among psychotropic medications, antipsychotic exposure was summarized as chlorpromazine equivalents to estimate the overall antipsychotic dose. However, detailed pharmacological profiles of individual agents, including sedative properties, anticholinergic effects, and receptor-binding characteristics, were not analyzed. The living environment before hospitalization was classified as either home or outside the home (psychiatric hospital or support facility).

The presence or absence of POD was determined retrospectively based on DSM-5 criteria through chart review during the postoperative period of the index surgical hospitalization. The postoperative period was defined as the interval from the end of the index surgery to discharge from the surgical hospitalization. Standardized delirium assessment tools, such as the Confusion Assessment Method or the Delirium Rating Scale-Revised-98, were not routinely available in this retrospective study. Board-certified psychiatrists involved in consultation-liaison psychiatric practice independently reviewed the medical records and determined the presence or absence of POD according to DSM-5 criteria. The reviewed sources included psychiatric consultation notes, physicians' notes, nursing records, medication changes, and records of physical restraint use. These psychiatrists examined documented clinical observations and descriptions suggestive of delirium, including acute confusion, disorientation, fluctuating cognitive status, impaired attention, altered level of consciousness, agitation, hallucinations, and sleep–wake cycle disturbance. In cases where it was difficult to distinguish POD from worsening of SSD symptoms, or when reviewers disagreed on the classification, the case was reviewed by multiple board-certified psychiatrists and the final classification was reached through discussion and consensus. Data on the use of physical restraints postoperatively, ICU admission, anesthesia (general or local), emergency or planned surgery, and operative time were also collected. Surgical procedures were classified according to the main surgical field or anatomical site. For procedures involving multiple sites, classification was based on the primary operative target or the main admitting surgical specialty. Surgery for malignancy was defined as surgery performed for a diagnosed or suspected malignant tumor, including both curative and palliative procedures. Long-duration surgery was defined as an operative time of ≥ 180 min, as the risk of worsening perioperative psychiatric symptoms increases beyond this cutoff[19,20]. Additionally, because body-image-altering procedures may affect postoperative psychological reactions[21,22], we investigated whether patients had undergone procedures that could substantially alter visible appearance or bodily function, including tracheostomy, amputation, mastectomy without reconstruction, gastrostomy, colostomy, nephrostomy, or eye resection.

## Statistical analysis

Continuous variables are presented as means with standard deviations or medians with interquartile ranges, as appropriate. Categorical variables are presented as numbers and percentages. The chi-square test was used when all expected cell counts were ≥ 5; otherwise, Fisher's exact test was used to assess associations between POD and background factors.

Missing values were not imputed in the primary analysis. Analyses were conducted using available data, and the number of missing values for each variable is reported in Table 1.

As this was a retrospective cohort study, no formal a priori sample size calculation was performed. Instead, the sample size was determined by the number of all eligible consultation-liaison psychiatry patients with SSDs who underwent surgery at the three participating hospitals during the predefined five-year study period. Since this was a relatively uncommon and clinically selected population, we considered it important to include all eligible patients identified during the study period in order to maximize the available sample size. Variables for the multivariable analysis were selected based on clinical relevance, previous evidence regarding POD risk factors[23], and the results of the univariate analyses, rather than on statistical significance alone. To reduce the risk of overfitting, the number of variables included in the multivariable model was restricted according to the number of patients who developed POD. Accordingly, because the number of POD events was limited, the multivariable analysis was planned and interpreted as an exploratory analysis with a restricted number of covariates, rather than as a definitive model for identifying independent risk factors. Associations among clinically related candidate variables were examined using cross-tabulation and Fisher's exact test, when relevant.

To assess the robustness of the findings, we also performed a complete-case sensitivity analysis excluding patients with missing laboratory or smoking data. The results of this analysis are presented in Supplementary Table 3.

For all statistical analyses, a two-tailed p-value of 0.05 was considered statistically significant. All analyses were performed using JMP, version 18 (SAS Institute, Cary, NC).

## Results

Among 208 surgical patients with SSDs who were referred to consultation-liaison psychiatry at the study sites during the study period, we included 200 patients after excluding eight patients who were admitted because of suicide attempts. Of these patients, 181/200 (90.5%) had schizophrenia, 9/200 (4.5%) had schizoaffective disorder, 5/200 (2.5%) had delusional disorder, and 5/200 (2.5%) had other SSD diagnoses. The mean age of the patients was 57.4 ± 14.4 years, with 71/200 (35.5%) aged ≥ 65 years and 122/200 (61.0%) being female. The median chlorpromazine equivalent of the administered antipsychotic was 400 (interquartile range [IQR], 200–714) mg, and 98/200 (49.0%) used BZRAs. The median operative time was 133 (IQR, 92–208) min. Surgical duration was ≥ 180 min in 76/200 (38.0%) patients. A total of 121/200 (60.5%) patients were hospitalized from their homes (Table 1). The distribution of surgical fields or anatomical sites is shown in Supplementary Table 1. The most common categories were musculoskeletal/spine surgery (49/200, 24.5%), gynecologic/obstetric surgery (32/200, 16.0%), and gastrointestinal/colorectal surgery (29/200, 14.5%).

In this study, 21/200 (10.5%) patients experienced POD; in particular, 12/71 (16.9%) patients aged ≥ 65 years developed POD. Only 1/21 (4.8%) patient with POD required transfer to the psychiatric ward. We first conducted univariate analyses to identify potential factors associated with POD.

Univariate analysis of factors associated with POD showed significant differences for hospitalization from outside the home (crude odds ratio [OR], 3.50; 95% confidence interval [CI], 1.35–9.13; $p < 0.01$), age ≥ 65 years (crude OR, 2.71; 95% CI, 1.08–6.80; $p = 0.03$), and albumin < 3.5 g/dL (crude OR, 3.18; 95% CI, 1.21–8.34; $p = 0.03$). Intensive care unit (ICU) admission (crude OR, 2.4; 95% CI, 0.96–5.99; $p = 0.06$), smoking before admission (crude OR, 2.30; 95% CI, 0.89–5.95; $p = 0.10$), hemoglobin < 12 g/dL (crude OR, 2.50; 95% CI,

| Factors | Number of patients (N = 200) |
|---|---|
| Male sex, n (%) | 78 (39.0) |
| Age, mean (SD), years | 57.4 (14.4) |
| Age ≥ 65 years, n (%) | 71 (35.5) |
| Hospitalization, days, median (IQR) | 11 (6–21) |
| Use of two or more antipsychotics, n (%) | 79 (39.5) |
| CPE, median (IQR), mg/day | 400 (200–714) |
| CPE < 300 mg/day, n (%) | 68 (34.0) |
| CPE ≥ 1000 mg/day, n (%) | 31 (15.5) |
| Use of BZRAs, n (%) | 98 (49.0) |
| Use of trazodone or mianserin, n (%) | 2 (1.0) |
| Use of sodium valproate, n (%) | 29 (14.5) |
| Use of ramelteon, n (%) | 9 (4.5) |
| Use of suvorexant or lemborexant, n (%) | 21 (10.5) |
| Charlson Comorbidity Index, median (IQR) | 4 (2–5) |
| Surgery for malignancy, n (%) | 62 (31.0) |
| Place of residence prior to hospitalization | |
| Home, n (%) | 121 (60.5) |
| Facility or hospital, n (%) | 79 (39.5) |
| Creatinine > 1.2 mg/dL, n (%)* | 12/199 (6.0) |
| Hemoglobin < 12 g/dL, n (%)* | 79/199 (39.7) |
| Albumin < 3.5 g/dL, n (%)* | 53/185 (28.6) |
| Psychiatric disease, n (%) | |
| Schizophrenia, n (%) | 181 (90.5) |
| Schizoaffective disorder, n (%) | 9 (4.5) |
| Delusional disorder, n (%) | 5 (2.5) |
| Other SSD diagnoses, n (%) | 5 (2.5) |
| Smoking before admission, n (%)[18] | 45/196 (23.0) |
| Physical restraint required, n (%) | 50 (25.0) |
| ICU admission, n (%) | 76 (38.0) |
| Body-image-altering procedures, n (%) | 16 (8.0) |
| General anesthesia, n (%) | 186 (93.0) |
| Emergency surgery, n (%) | 39 (19.5) |
| Surgical time, median (IQR), min | 133 (92–208) |
| Surgical time ≥ 180 min, n (%) | 76 (38.0) |

**Table 1**. Patient characteristics. CPE, chlorpromazine equivalent; BZRAs, benzodiazepine receptor agonists; ICU, intensive care unit; IQR, interquartile range; SD, standard deviation. *Missing values: creatinine (n = 1), hemoglobin (n = 1), albumin (n = 15), smoking (n = 4).

0.98–6.45; $p = 0.06$), and Charlson Comorbidity Index ≥ 4 (crude OR, 2.47; 95% CI, 0.92–6.66; $p = 0.10$) were not significantly related to the development of POD. We observed no significant differences in surgery for malignancy, surgery duration of ≥ 180 min, body-image-altering procedures, emergency surgery, use of two or more antipsychotic medications, or antipsychotic medication dose (Table 2). As low albumin level and pre-admission residence outside the home were considered to overlap clinically with older age, we examined their associations with age ≥ 65 years. Low albumin level and pre-admission residence outside the home were more frequent among patients aged ≥ 65 years than among those aged < 65 years (Supplementary Table 2).

As 21 patients developed POD, the multivariable model was restricted to three variables according to the number of POD events to reduce the risk of overfitting. Age ≥ 65 years, smoking before admission, and ICU admission were selected for the multivariable model based on clinical relevance, previous evidence regarding POD risk factors, and the results of the univariate analyses. Although low albumin level and pre-admission residence outside the home were associated with POD in the univariate analyses, these variables were not included in the multivariable model because they were considered to overlap clinically with older age. Cross-tabulation showed that both low albumin level and pre-admission residence outside the home were more frequent among patients aged ≥ 65 years than among those aged < 65 years (Supplementary Table 2). In this exploratory multivariable model, age ≥ 65 years (adjusted OR, 3.21; 95% CI, 1.21–8.99; $p = 0.02$) and smoking before admission (adjusted OR, 2.90; 95% CI, 1.01–8.24; $p = 0.05$) were associated with increased odds of POD (Table 3). Given the limited number of POD events, these findings should be interpreted as exploratory associations rather than definitive independent risk factors. In the complete-case sensitivity analysis excluding patients with missing laboratory or smoking data, 181 patients, including 19 patients with POD, were analyzed. The direction of the associations was

| | Number of patients without postoperative delirium (n = 179) | Number of patients with postoperative delirium (n = 21) | Odds ratio | 95% CI | p |
|---|---|---|---|---|---|
| Sex | | | | | |
| Male | 72 | 6 | Reference | | |
| Female | 107 | 15 | 1.68 | 0.62–4.50 | 0.35 |
| Age | | | | | |
| < 65 years | 120 | 9 | Reference | | |
| ≥ 65 years | 59 | 12 | 2.71 | 1.08–6.80 | 0.03 |
| Use of BZRAs | 89 | 9 | 0.76 | 0.30–1.89 | 0.65 |
| Use of sodium valproate | 28 | 1 | 0.27 | 0.03–2.09 | 0.32 |
| Use of suvorexant or lemborexant | 17 | 4 | 2.24 | 0.68–7.43 | 0.25 |
| Use of two or more antipsychotics | 70 | 9 | 1.16 | 0.47–2.92 | 0.74 |
| CPE < 300 mg/day | 63 | 5 | 0.58 | 0.20–1.64 | 0.34 |
| CPE ≥ 1000 mg/day | 29 | 2 | 0.54 | 0.12–2.47 | 0.54 |
| Smoking before admission | 37 | 8 | 2.30 | 0.89–5.95 | 0.10 |
| Place of residence prior to hospitalization | | | | | |
| Home | 114 | 7 | Reference | | |
| Facility or hospital | 65 | 14 | 3.50 | 1.35–9.13 | < 0.01 |
| Charlson Comorbidity Index ≥ 4 | 90 | 15 | 2.47 | 0.92–6.66 | 0.10 |
| Surgery for malignancy | 57 | 5 | 0.67 | 0.23–1.92 | 0.45 |
| Creatinine > 1.2 mg/dL | 12 | 0 | NE | NE | 0.61 |
| Hemoglobin < 12 g/dL | 67 | 12 | 2.50 | 0.98–6.45 | 0.06 |
| Albumin < 3.5 g/dL | 43 | 10 | 3.18 | 1.21–8.34 | 0.03 |
| ICU admission | 64 | 12 | 2.40 | 0.96–5.99 | 0.06 |
| Body-image-altering procedures | 13 | 3 | 2.13 | 0.55–8.18 | 0.23 |
| Emergency surgery | 34 | 5 | 1.34 | 0.46–3.89 | 0.57 |
| Surgical time | | | | | |
| < 180 min | 111 | 13 | Reference | | |
| ≥ 180 min | 68 | 8 | 1.00 | 0.40–2.55 | > 0.999 |
| Anesthesia | | | | | |
| Local | 13 | 1 | Reference | | |
| General | 166 | 20 | 1.57 | 0.19–12.61 | > 0.999 |

**Table 2**. Factors associated with postoperative delirium: Univariate analysis. CI, confidence interval; BZRAs, benzodiazepine receptor agonists; CPE, chlorpromazine equivalent; ICU, intensive care unit; NE, not estimable. Patients with missing data were excluded from the corresponding univariate analyses.

| | Odds ratio | 95% CI | p |
|---|---|---|---|
| ICU admission | 1.97 | 0.77–5.20 | 0.16 |
| Smoking before admission | 2.90 | 1.01–8.24 | 0.05 |
| Age ≥ 65 years | 3.21 | 1.21–8.99 | 0.02 |

**Table 3**. Multivariable logistic regression analysis of factors associated with postoperative delirium. The multivariable model included 196 patients with complete data on age, smoking status, and ICU admission, including 21 patients with POD. Patients with missing smoking data were excluded from this model. CI, confidence interval; ICU, intensive care unit.

broadly consistent with that in the primary analysis, although the confidence intervals were wider because of the reduced sample size (Supplementary Table 3).

## Discussion

### Comparisons with previous studies

In the present study, the frequency of POD in this consultation-liaison cohort of patients with SSDs was approximately 10%, and only 0.5% required transfer to a psychiatric ward. In this study, POD occurred in 16.9% of patients aged ≥ 65 years and 7.0% in those aged < 65 years. In a previous study of the general population over 18 years of age[23], the frequency of POD was 6.3% in those aged ≥ 65 years and 2.3% in those aged 18–65 years. In the present study, POD occurred about three times more often than in that previous study. Importantly, these findings should be interpreted in light of the selected nature of the study population. As all participants

had been referred to consultation-liaison psychiatry during surgical hospitalization, they may have had greater psychiatric complexity, behavioral concerns, or perceived management needs than surgical patients with SSDs who were not referred for psychiatric consultation. Therefore, the observed frequency of POD may be higher than that in the broader population of surgical patients with SSDs and should not be interpreted as the frequency of POD among all surgical patients with SSDs. Nevertheless, it is noteworthy that even in this selected consultation-liaison cohort, POD was documented in only approximately 10% of patients, and psychiatric ward transfer after POD was required in only one patient. These findings suggest that, although the present estimates may overestimate the frequency of POD among surgically hospitalized patients with SSDs, POD requiring psychiatric ward transfer may be relatively uncommon when consultation-liaison psychiatric expertise is available. Among problematic behaviors from a medical safety perspective in patients with SSDs who had undergone surgery, Tsuji et al. reported bizarre behavior in 52.4% (11/21) of patients with psychiatric diseases who had surgery (15 of whom had schizophrenia)[24], and Farasatpour et al. reported that 19.6% (11/56) and 21.4% (12/56) of patients with schizophrenia who underwent surgery for breast cancer verbally and physically attacked their caregivers, respectively[25]. Cooke et al. observed disruptive behavior in 29% (16/55) of patients with schizophrenia who underwent surgery for acute appendicitis[26]. However, these previous studies did not clarify whether these behaviors that interfered with physical treatment during the perioperative period were caused by POD, worsening of psychiatric symptoms due to SSDs, or the patients' own personality traits. In this study, we were able to describe the frequency of POD in this consultation-liaison cohort of patients with SSDs by reviewing postoperative psychiatric symptoms and related clinical records over a longer period and at more facilities than in previous studies. A key contribution of this study is that it specifically describes POD among consultation-liaison psychiatry patients with SSDs undergoing surgery, rather than broadly describing perioperative behavioral problems or psychiatric symptom worsening. The study also provides information on psychiatric ward transfer after POD, an outcome that has rarely been reported in previous studies.

In our previous study of patients with SSDs conducted at the same facility as the present study, the frequency of worsening of psychiatric symptoms other than postoperative delirium and insomnia was 11.1%[19]. Taken together with our previous findings, the present results suggest that clinically significant postoperative mental status deterioration, including POD and worsening of psychiatric symptoms, may not be uncommon among surgical patients with SSDs. However, because the definitions and study populations differed, these figures should not be directly combined or interpreted as a precise overall incidence. Compared with previous studies[24–26], the present study focused on patients with SSDs who developed POD and was conducted over a longer period to ensure a larger number of eligible patients. In patients with SSDs, older age, low albumin level, and pre-admission residence outside the home were associated with POD in the univariate analyses. These factors may partly reflect frailty and functional vulnerability, which are known to be associated with POD in the general population. In the multivariable analysis, age ≥ 65 years remained associated with POD. However, because the number of POD events was small and the model included only a restricted number of covariates, this analysis should be regarded as exploratory. Therefore, the selected covariates and observed associations should not be interpreted as establishing definitive independent risk factors, but rather as hypothesis-generating findings that require confirmation in larger studies. Meanwhile, there was no significant association between POD occurrence and the dosage of antipsychotic medication or the use of BZRAs in this cohort. However, the antipsychotic dose was summarized using chlorpromazine equivalents, which reflect overall antipsychotic exposure but do not fully capture differences in pharmacological profiles among individual agents, such as sedative properties, anticholinergic effects, or receptor-binding characteristics. Therefore, the lack of a significant association between antipsychotic dose and POD should be interpreted cautiously.

The use of BZRAs is generally considered a risk factor for POD[23], although one previous study reported that the frequency of delirium among patients who continued BZRAs during the perioperative period was not higher than that among patients who did not use BZRAs[27]. The lack of a significant association between BZRA use and POD in the present study should also be interpreted cautiously because of the limited sample size, retrospective design, and possible residual confounding. In addition, confounding by indication may have been present, because patients prescribed BZRAs may have differed in baseline insomnia, anxiety, illness severity, or other unmeasured clinical characteristics that could influence POD risk. Future studies with more detailed medication data, including individual drug types and pharmacological characteristics, are needed to better clarify the relationship between psychotropic medications and POD risk.

Among the patients with SSDs who developed POD, only one patient required transfer to a psychiatric ward, which was 0.5% of the total cohort. However, this low transfer rate should be interpreted within the context of the selected study population. This study included surgical patients with SSDs who were referred to consultation-liaison psychiatry and excluded patients admitted primarily because of acute psychiatric crises, such as suicide attempts. Therefore, the low psychiatric ward transfer rate observed in this study should not be generalized to all surgical patients with SSDs, particularly those requiring urgent surgical care under conditions of psychiatric instability. Within this selected consultation-liaison cohort, most cases of POD were managed by adjusting psychotropic medications, and psychiatric ward transfer after POD was extremely rare. These findings may provide clinically relevant information for hospitals considering surgical treatment of patients with SSDs and may help reduce excessive concerns about the need for psychiatric ward transfer when consultation-liaison psychiatric expertise is available. However, the broader applicability of this finding requires further study.

## Strengths and limitations

Owing to the retrospective study design, several limitations should be considered. First, unmeasured items could not be evaluated. Specifically, the severity of psychiatric symptoms at the time of admission could not be assessed using a unified scale, and the severity of cognitive impairment due to SSDs could not be assessed. Therefore, we collected information on the place of residence prior to hospitalization and antipsychotic medication dosage as

proxy indicators of psychiatric symptom severity. Second, the diagnosis of POD was based on retrospective chart review rather than standardized delirium assessment instruments, such as the Confusion Assessment Method or the Delirium Rating Scale-Revised-98. Although cases were reviewed by board-certified psychiatrists involved in consultation-liaison psychiatric practice and classified based on DSM-5 criteria, the absence of standardized instruments may have led to underdiagnosis or overdiagnosis of POD. Distinguishing POD from exacerbation of underlying psychotic symptoms in patients with SSDs is also inherently challenging in a retrospective design. In ambiguous cases, the final classification was determined by consensus among reviewers based on the available clinical documentation; however, diagnostic uncertainty and potential misclassification cannot be completely excluded. In addition, because reviewers were not formally blinded to all risk-factor information, classification bias may have occurred. Third, this study included only surgical patients with SSDs who were referred to consultation-liaison psychiatry. This sampling approach may have introduced selection bias, because patients who received psychiatric consultation may have had greater psychiatric complexity, behavioral concerns, more complex medication regimens, or higher perceived perioperative management needs than surgical patients with SSDs who were not referred. Therefore, the observed frequency of POD in this cohort may have been higher than that in the broader population of surgical patients with SSDs. As data on all surgical patients with SSDs who did not receive psychiatric consultation were not available, we could not determine the proportion of surgical patients with SSDs who received consultation-liaison psychiatric services during the study period. Future studies should include all surgical patients with SSDs, regardless of psychiatric referral, to more accurately estimate the frequency of POD and assess the generalizability of the present findings. Fourth, we excluded patients who were admitted primarily because of acute psychiatric crises, including suicide attempts, because their mental health status was unstable before admission. This exclusion may have reduced the observed rate of transfer to a psychiatric ward and limits the generalizability of the findings to patients with SSDs requiring urgent surgical care under conditions of psychiatric instability. Therefore, the low psychiatric ward transfer rate observed in this study should be interpreted as applying to a pre-selected, psychiatrically managed surgical cohort rather than to all patients with SSDs requiring surgical treatment. Fifth, although we described the distribution of surgical fields or anatomical sites, the limited number of POD events prevented detailed analyses stratified by surgical field, surgical procedure, or anatomical site. Finally, the small number of POD events limited the number of variables that could be included in the multivariable analysis. Although the final sample size was considered appropriate for estimating the frequency of POD in this selected consultation-liaison cohort, the number of POD events was limited. Therefore, analyses of associated factors, including the multivariable analysis, should be interpreted as exploratory and hypothesis-generating rather than as establishing definitive independent risk factors. In addition, although low albumin level and pre-admission residence outside the home were associated with older age in cross-tabulation, formal multicollinearity assessment among candidate variables was not performed, and alternative model specifications including these variables may have yielded different results. Confirmation in larger prospective studies with sufficient numbers of POD events is required. Despite these limitations, a strength of this study is that it included a larger sample size than previous studies, allowing us to estimate the frequency of POD in consultation-liaison psychiatry patients with SSDs and demonstrate that the frequency of transfers to psychiatric wards was low in this selected cohort. Future research should utilize standardized delirium assessment tools to clarify the frequency and determinants of POD in patients with SSDs. Studies with larger sample sizes are needed to investigate a broader range of factors associated with the development of POD and to help guide hospital selection for SSD patients requiring physical treatment.

## Conclusion

In this retrospective cohort of surgical patients with SSDs who were referred to consultation-liaison psychiatry, after excluding patients admitted primarily because of acute psychiatric crises, POD was documented in approximately 10% of patients. Most cases were managed through psychotropic medication adjustment, and only a very small number of patients required transfer to a psychiatric ward. These findings suggest that POD in psychiatrically managed surgical patients with SSDs may often be manageable in general hospitals when consultation-liaison psychiatric expertise is available and may provide useful information for hospitals considering surgical treatment of this population. However, the observed frequency of POD and the low psychiatric ward transfer rate should not be generalized to all surgical patients with SSDs, particularly those with unstable psychiatric symptoms before admission or those requiring urgent surgical care under conditions of psychiatric instability.

## Data availability

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

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## Author contributions

YM, N. Ayani, MF, and T. Funatsuki conceived of the study. YM and N. Ayani developed the methodology, curated the data, conducted formal analysis, and were responsible for project administration. YM, NA, MF, T. Funatsuki, T. Fukao, SU, AT, N. Oya, and RK conducted the investigation. YM wrote the original manuscript draft. YM, N. Ayani, MF, T. Funatsuki, T. Fukao, SU, AT, N. Oya, RK, SI, and JN reviewed and edited the manuscript. N. Ayani gathered the resources for this study. N. Ayani, SI, and JN supervised the study.

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## Declarations

## Competing interests

The authors declare no competing interests.

## Ethics approval

This retrospective cohort study was approved by the Ethics Committee of Kyoto Prefectural University of Medicine (approval no. ERB-C-3189) and by the Ethics Committees of Okayama University and Kansai Medical University. The requirement for informed consent was waived by the committees due to the retrospective nature of the study. All methods were carried out in accordance with relevant guidelines and regulations.

## Use of generative AI tools

During the preparation of this work, the authors used ChatGPT (OpenAI) to assist with language editing, proofreading, and improving clarity of the manuscript. The authors reviewed and edited all AI-assisted output and take full responsibility for the content of the manuscript.

## Additional information

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