General Hospital Psychiatry 58 (2019) 51–58

Contents lists available at ScienceDirect

General Hospital Psychiatry

journal homepage: www.elsevier.com/locate/genhospsych

Risk factors for early unplanned readmission in patients with bipolar disorder: A retrospective observational study

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ARTICLE INFO

Keywords:
Unplanned readmission
Bipolar disorder
Administrative database
Japan

ABSTRACT

Objectives: Evidence regarding the relationships between patient, hospital, and regional factors and early unplanned readmission (short-term outcome) in patients with bipolar disorder is lacking. This study aimed to examine risk factors associated with early unplanned readmission in patients with bipolar disorder.

Method: We retrospectively analyzed adult bipolar patients (ICD-10; F31) between April 2012 and March 2014 in the Japanese Diagnosis Procedure Combination database. We examined factors affecting the 30-day unplanned readmission using multivariable logistic regression analysis.

Results: A total of 2688 patients admitted to psychiatric beds were included. Multivariate analysis showed that unchanged or exacerbation discharge outcome (adjusted odds ratio [aOR]: 1.93; 95% confidence interval [CI]: 1.06–3.51, $p = 0.031$), unplanned or urgent admission settings (aOR: 1.51; 95% CI: 1.00–2.26, $p = 0.048$), physical comorbidity (chronic pulmonary disease) (aOR: 4.74; 95% CI: 1.30–17.29, $p = 0.018$), presence of psychiatric acute-care beds (aOR: 1.72; 95% CI: 1.02–2.87, $p = 0.040$), and intermediate-level hospital psychiatric staffing (aOR: 1.82; 95% CI: 1.14–2.91, $p = 0.012$) were significantly associated with higher early unplanned readmission, while higher density of psychiatrists in the area (aOR: 0.50; 95% CI: 0.29–0.87, $p = 0.014$) was significantly associated with lower early unplanned readmission.

Conclusions: The results suggest that not only careful management of high-risk patients but also consideration of functional differentiation in psychiatric inpatient care, psychiatric resource allocation, and follow-up support for patients with bipolar disorder are needed for reducing the early unplanned readmission rate.

1. Introduction

Policies for improving mental health care are an important priority in many developed countries [1]. Readmission rate is considered to be one of the important quality indicators of care and focus of interest for all health sector policymakers [2]. In general, readmissions can be disruptive for patients and their families, and increase cost burden [3]. Especially, early or unplanned readmission could reflect a lack of appropriate management as many countries are transitioning from hospital to community-based integrated care [1]. Thus, identifying risk factors associated with early unplanned readmission would inform policymakers and facilitate identification of high-risk patients for future interventions.

Some previous studies have investigated the factors associated with psychiatric readmissions. Such factors include the number of previous psychiatric hospitalizations, symptom severity, comorbidities including anxiety disorder and alcohol intoxication, sex, body mass index, treatment in the community post discharge, and socioeconomic factors such as type of residence at initial admission [4–8]. However, a previous study indicated that readmission risk factors may differ for affective and nonaffective disorders [9]. Therefore, evidence on early unplanned readmission in each disease category is needed.

In 2016, the World Health Organization ranked “mental and substance use disorders” as the sixth leading cause of disability-adjusted

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https://doi.org/10.1016/j.genhosppsych.2019.03.003
Received 26 December 2018; Received in revised form 15 March 2019; Accepted 16 March 2019

life years (DALYs) worldwide, which is the third leading cause of DALYs in high-income countries [10]. DALY is based on years of life lost from premature death and years of life lived without full health. Among mental and substance use disorders, bipolar disorder places a substantial economic burden on society [11] and is the most expensive behavioral healthcare diagnosis [12]. However, limited studies on readmissions in patients with bipolar patients are available.

In addition, few studies focused on the relationship between psychiatric readmission and hospital factors such as hospital psychiatric staffing, which were associated with psychiatric acute-care level (acute, chronic, and mixed), and regional factors such as density of psychiatric beds or psychiatrists, which influence whether care can be provided in the community. For example, lower density of psychiatrists in the area would be associated with an increased risk for early unplanned readmission due to the insufficient follow-up care. We hypothesized that not only patient factors but also hospital and regional factors would affect early unplanned readmission. Using administrative database allowed an investigation of this association.

This study aimed to determine the risk factors of early unplanned readmission in patients with bipolar disorder. It also focused on variables associated with psychiatric healthcare policy such as hospital psychiatric staffing and regional healthcare resources.

2. Methods

2.1. Brief background of Japanese psychiatric care settings

Japan achieved universal health coverage in 1961, which ensures equitable access to health services with little regard to patients' socioeconomic circumstances. The details of the Japanese healthcare system have been described elsewhere [13]. Hospitals in Japan are classified into four categories – acute-care, mixed-care, long-term care, and psychiatric – and each hospital can have psychiatric beds based on the License system. Recently, Japan underwent deinstitutionalization of psychiatric care, which resulted in a shorter psychiatric length of stay (LOS), but it was still longer than that in other Organization for Economic Co-operation and Development (OECD) countries; the average LOS of newly admitted patients in Japan is about 60 days [14] while that in patients with mental and behavioral disorders are 37.7 days in the UK (in 2015), 14.2 days in Australia (in 2014), and 36.6 days in New Zealand (in 2014) [15]. According to the published summary table pertaining to the unadjusted 30-day readmission rate of the psychiatric patients, the rate to the same hospital was 9.2% [16] and that to any hospital's psychiatric ward was 9.7% in the Japanese national cohort [17]. Besides, these data did not distinguish planned and unplanned readmission, and were different in data source, patient population and followed-up periods. Additionally, data regarding readmission rate in bipolar disorder patients are scarce.

2.2. Data source

This was a retrospective, observational study using data from a Japanese administrative database, Diagnosis Procedure Combination per-diem payment system (DPC/PDPS). The details of the DPC/PDPS have been described elsewhere [18].

Briefly, the DPC/PDPS is a case-mix patient classification system that has been linked to payments at acute-care and mixed-care hospitals in Japan. The DPC/PDPS-based hospital reimbursement system had been adopted by > 1400 hospitals by 2011, accounting for more than half of the total 910,000 hospital beds nationwide. Psychiatric patients admitted to and discharged from acute-care and mixed-care hospitals were reviewed and analyzed. However, psychiatric patients from psychiatric hospitals were not included in the present study because psychiatric hospitals did not participate in the DPC/PDPS system. One of the differences in statistical aspects between psychiatric patients in acute-care and psychiatric hospitals was the average LOS: 35.2–50.3 days in acute-care hospitals and 61.5 days for newly admitted patients in psychiatric hospitals [14,19].

Anonymous clinical and administrative claims data were collected annually for patients from the participating hospitals. Clinical data consist of baseline patient information, diagnosis information using the ICD-10, and detailed medical information such as all major or minor procedures, medication, and device use. The database also includes purpose of admission, discharge destination, and outcome at the time of hospital discharge. Hospital information such as presence of psychiatric acute-care beds was also collected under the DPC/PDPS. The database includes unique hospital identifiers and unique patient identifiers within the same hospital.

This study was approved by the institutional review board at Tokyo Medical and Dental University and the National Center for Child Health and Development. The board waived the requirement for patients' informed consent because of the anonymous nature of the data.

2.3. Participants

We extracted data on psychiatric patients with bipolar disorder (ICD-10 codes F31) admitted for a therapeutic purpose from the DPC database between April 1, 2012 and March 31, 2014, from hospitals that have 40 or more psychiatric beds. We did not include data from hospitals with fewer than 40 psychiatric beds as we aimed to capture readmissions to the same hospital. We did not include bipolar patients who used general acute-care beds during the index admissions because such patients needed care for non-psychiatric diseases.

Exclusion criteria were as follows: age younger than 15 years, death during hospital stay, repeated readmission records within 30 days of discharges, planned readmission records with prior admission records, receiving major surgical procedures, missing essential variables or hospital information, unknown discharge settings, and outlier hospital LOS (120> days). Admissions between October 2013 and March 2014 were used for follow-up only; new admissions were excluded from the study cohort to avoid sampling bias in terms of follow-up period. In the database, readmission types were categorized into planned and unplanned readmission based on the physician's observation. Additionally, patients spending more than three nights outside the hospital (day of absence from the hospital within a patient's stay) were also excluded as outliers.

2.4. Clinical, procedural, and hospital characteristics

We obtained data regarding both individual- and hospital-level characteristics. The individual variables included age, sex, admission status (planned, unplanned, or urgent), use of ambulance, discharge settings (outpatient services, transfer to other hospitals, transfer to healthcare or welfare facilities, and others), and discharge outcome (cured, resolved or remission, unchanged or exacerbation, and others). Admission information in relation to the Act on Mental Health and Welfare for the Mentally Disabled (voluntary and involuntary commitment) were also extracted from the database. Age was categorized into four groups (years): 15–29, 30–49, 50–64, and 65 and over.

The severity of psychiatric illness was scored using Global Assessment of Functioning (GAF) at index admission. GAF scores range from 1 to 100, and higher scores denote better functioning. They were categorized into five groups: 1–20 (danger or hurting self or others), 21–30 (severely delusional), 31–40 (some impairment in reality testing), 41–60 (moderate or serious symptoms), 61–100 (generally functioning well), and unknown. GAF at index discharge was not used due to data unavailability. In terms of selected medical services for psychiatric patients, complication treatment services [Japanese procedure code (JPC), A230] and electroconvulsive therapy with anesthesia [JPC, I100] were also obtained from the database. These services are classified by the JPC linked to administrative claims data, which include all the prices for every procedure performed. Data on Elixhauser's

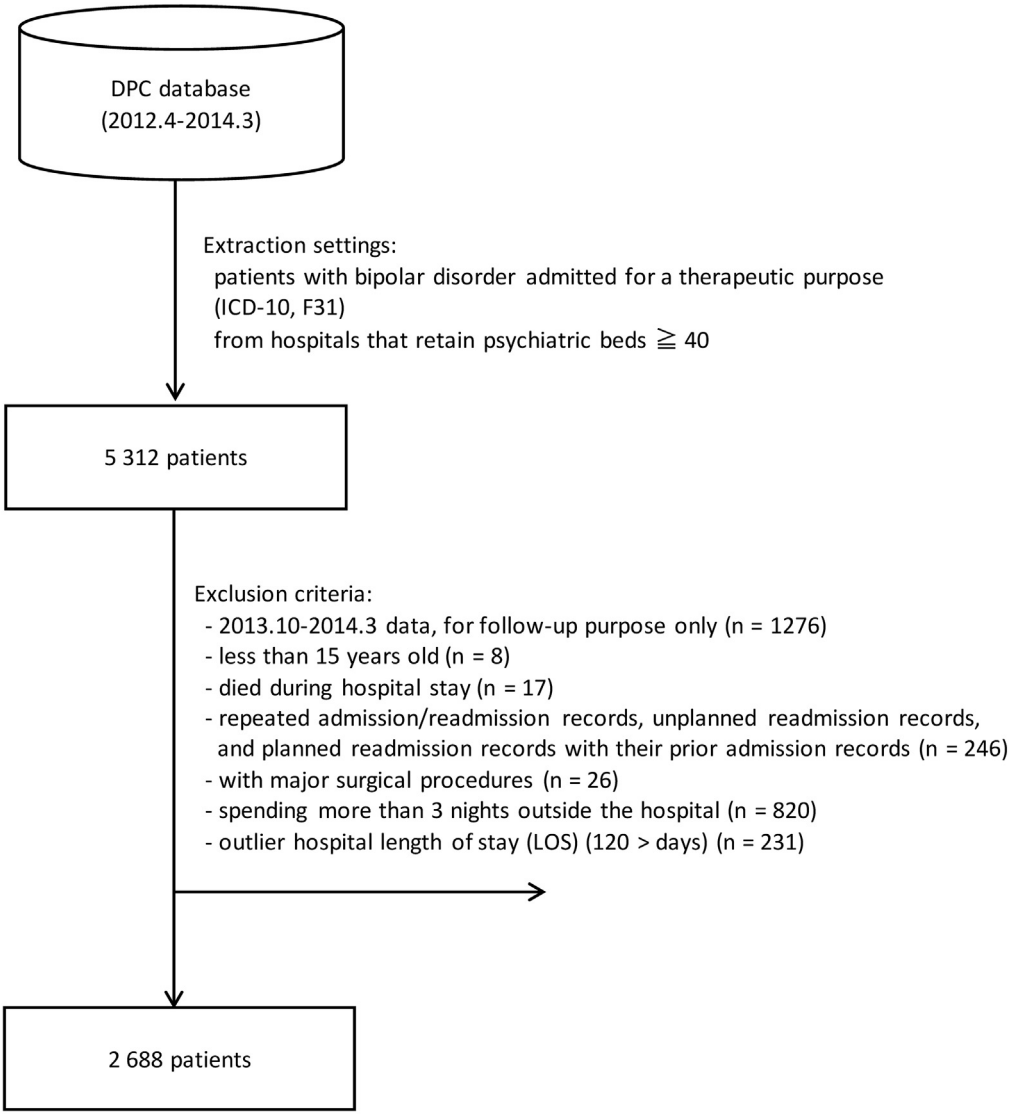

Fig. 1. Flowchart presenting the selected study population.

(physical) comorbidities were obtained based on Quan's methodology [20]. LOS at index admissions were categorized into three groups according to the quartile distribution: first quartile, interquartile, and fourth quartile.

Hospital-level characteristics included academic status (academic or non-academic), ownership (public or private), psychiatric hospital charge index (pHCI, 7:1, 10:1, 13:1, and 15:1), and presence of psychiatric acute-care beds. pHCI is related to the nurse-to-inpatient ratio and associated with psychiatric hospital acute-care function. In general, hospitals with pHCI 7:1 and 10:1 provided acute-care services for severe psychiatric patients, with pHCI 15:1 cared for mild or chronic psychiatric patients and transferred severe psychiatric patients to other hospitals, and with pHCI 13:1 cared for a variety of psychiatric patients from mild/chronic to severe. Hospitals with acute-care psychiatric services were defined as those with acute psychiatric beds [JPC, A311, A3112, and A3113].

Density of psychiatric beds and psychiatrists was calculated using data from public surveys as follows: Survey of Physicians, Dentists and Pharmacists, Survey of Medical Institutions, and Basic Resident Registration. Data for these surveys were obtained from the *E*-STAT website (http://www.e-stat.go.jp/SG1/estat/eStatTopPortalE.do). Each density was obtained per healthcare geographical unit, Secondary Healthcare Service Area [21], and categorized into lowest quartile, interquartile, and highest quartile. For density of psychiatric beds, the categories were: (i) lowest quartile, < 1.83; (ii) interquartile, 1.83–3.58; and (iii) highest quartile, ≥ 3.58. For density of psychiatrists, they were: (i) lowest quartile, < 0.098; (ii) interquartile, 0.098–0.169; and (iii) highest quartile, ≥ 0.169.

The primary outcome of this study was unplanned readmission to the same hospital within 30 days of discharge from the index admission (30-day unplanned readmissions). Readmissions to other hospitals were not captured due to data unavailability (patient identifiers differed at each hospital). Thirty-day unplanned readmission, not only for psychiatric but also non-psychiatric reasons were captured in this study.

2.5. Statistical analysis

Continuous variables were expressed as mean ± SD or median and

interquartile range (IQR), depending on the overall variable distribution, and categorical variables were expressed as proportions.

Descriptive statistics were obtained for the study cohort. We used univariate and multivariate logistic regression to identify factors associated with the 30-day unplanned readmission. We examined the following covariates: age, sex, admission settings, use of ambulance, discharge outcome, voluntary/involuntary commitment, GAF, use of selected psychiatric services, Elixhauser's comorbidities ($N \geq 5$), LOS categories, academic hospital, hospital ownership, hospital charge index, presence of psychiatric acute-care beds, density of psychiatric beds, and density of psychiatrists. Inclusion of variables in the model was based on existing knowledge of risk factors for readmissions in psychiatric patients together with hospital/regional factors that may affect readmissions. All the covariates mentioned above were considered in the multivariate regression model; however, some variables were excluded from the model because of the number of patients in each category. Variance Inflation Factor (VIF) was used to check for multicollinearity. Predictive and complexity characteristics of the model were considered during modeling.

All statistical analyses were performed using R statistical software, version 3.3.2 (R Foundation for Statistical Computing, Vienna, Austria). The analyses were two-tailed, and P-values < 0.05 were considered statistically significant. We did not impute any missing data in the present study.

3. Results

3.1. Patient characteristics

The bipolar cohort included 2688 patients after exclusions from an initial draw of 5312 potential participants (see Fig. 1).

Table 1 presents the characteristics of patients in this study. Crude unplanned readmission ratio within 30 days of discharge was 5.0%, while age-sex standardized 30-day readmissions ratio of the selected OECD countries was about 11.4% [1]. About one-third of patients were aged 30–49 years (34.2%), and the male/female ratio was 18:82. Patients who were discharged with unchanged or exacerbation outcome showed higher 30-day unplanned readmissions. Physical (Elixhauser's) comorbidities were associated with relatively higher 30-day unplanned readmissions. The median and interquartile of the LOS were 33 days (IQR 19–57) for the unplanned readmission group and 34 days (IQR 17–56) for the control group. The distribution of LOS of the bipolar disorder cohort is right-skewed (Fig. 2).

3.2. Predictors for 30-day unplanned readmissions

In the univariate regression model, with 30-day unplanned readmission as the dependent variable, the following variables were associated with an increasing risk of 30-day unplanned readmission: aged 50–64 years, unplanned or urgent admission setting, unchanged or exacerbation discharge outcome, chronic pulmonary disease as a physical comorbidity, and pHCI 13:1 (intermediate-level psychiatric staffing). Meanwhile, higher density of psychiatrists was associated with a decreasing risk of 30-day unplanned readmission (Table 2).

Multivariate logistic regression analysis showed that unplanned or urgent admission setting was associated with a 30-day unplanned readmission (aOR, 1.51; 95% CI, 1.00–2.26, $p = 0.048$). Additionally, patients who were discharged with an outcome of unchanged or exacerbated status (aOR, 1.93; 95% CI, 1.06–3.51, $p = 0.031$) or had chronic pulmonary disease as a physical comorbidity (aOR, 4.74; 95% CI, 1.30–17.29, $p = 0.018$) were more likely to have an unplanned readmission within 30 days of discharge. In terms of hospital factors, pHCI 13:1 (aOR, 1.82; 95% CI, 1.14–2.91, $p = 0.012$) and presence of psychiatric acute-care beds (aOR, 1.72; 95% CI, 1.02–2.87, $p = 0.040$) were associated with higher 30-day unplanned readmission. Within regional factors, higher density of psychiatrists was associated with lower unplanned readmission within 30 days of discharge (aOR, 0.50; 95% CI, 0.29–0.87, $p = 0.014$).

The model showed a modest discrimination with a c-index of 0.67. None of the VIF values were up to 10, and the mean VIF of the model was < 6, suggesting that there were no collinearity problems.

4. Discussion

Our study revealed risk factors associated with early unplanned readmission in patients with bipolar disorder. To our knowledge, this is one of the first studies that assessed the effect of patient, hospital, and regional factors on early unplanned readmission in patients with bipolar disorder. The study yielded several important findings. First, patient admission settings and discharge outcome were associated with early unplanned readmission. Second, physical comorbidities showed relatively higher ratio with early unplanned readmission. Third, intermediate-level hospital psychiatric staffing (pHCI 13:1) was associated with higher early unplanned readmission. Fourth, higher density of psychiatrists was associated with lower early unplanned readmission.

Although the evidence of factors on early unplanned readmission in patients with bipolar disorder was scarce, the following two factors are consistent with clinical expectations. 1) Index admission with unplanned or urgent settings was associated with higher early unplanned readmission, which is partly because hospitals had more information on patients with planned index admission than patients without it, leading to appropriate care rather than heuristic therapeutic options. 2) Patients who were discharged with unchanged or exacerbation outcomes were more likely to be readmitted than those who were not, due to the inappropriate discharge outcome. Contrary to some previous studies, we found no effect of age on readmission [22,23]. In addition, the results showed that lower GAF score was not associated with early unplanned readmission, which is inconsistent with prior researches on bipolar disorder patients [22] and psychiatric patients [24,25]. This is partly due to the limitation on data availability of GAF score at discharge.

Most physical comorbidities showed higher early unplanned readmission although only chronic pulmonary disease showed significant association in the multivariable regression analysis (Table 1, Table 2). The result was consistent with a previous research that reported an association between cardiometabolic comorbidities and 30-day readmission in bipolar patients [26] and psychiatric patients [27]. A better service provision for patients with bipolar disorder, especially those with physical comorbidities, needs to be considered, such as treatment by not only psychiatrists but also other medical specialists.

Being admitted to a facility with pHCI 13:1 was associated with higher early unplanned readmission, which is partly because some of these hospitals were undifferentiated, which leads to inadequate systematic care. As pHCI were associated with psychiatric hospital acute-care function, it would be better for hospitals with pHCI 13:1 to transfer severe patients to hospitals providing psychiatric acute-care services. Additionally, appropriate allocation of psychiatric resource by hospitals would be attractive, which was also implied by one of the characteristics of the Japanese psychiatric healthcare system: greater number of psychiatric beds per capita with relatively longer LOS than other OECD countries [15].

Hospitals with psychiatric acute-care beds were associated with early unplanned readmission. To some extent, this is because such hospitals could take care of more severe patients than could other hospitals. Moreover, hospitals' psychiatric services were influenced by whether there are psychiatric hospitals nearby. Further research considering regional psychiatric resources and staffing (function) are needed to achieve better patient outcomes.

It is interesting that patients who resided in the regions with higher psychiatrist density were less likely to be readmitted. In general, bipolar disorder is often first diagnosed after several years of symptoms, and is a disabling psychiatric illness that is often misdiagnosed, especially on

Table 1
Characteristics of patients.

	No-unplanned readmission	unplanned readmission	Proportion of unplanned readmission	
Variables	N	N	%	
	2553	**135**	**5.02%**	
Patient factors				
Age group (years)				
15–29	262	17	6.09%	
30–49	882	37	4.03%	
50–64	784	53	6.33%	
65 and over	625	28	4.29%	
Sex				
Male	458	26	5.48%	
Female	2096	109	4.92%	
Use of ambulance	109	7	6.03%	
Admission settings				
Planned	1214	53	4.18%	
Unplanned or urgent	1339	82	5.77%	
Discharge settings				
Outpatient services	2414	133	5.22%	
Transfer to other hospitals	124	1	0.80%	$
Transfer to healthcare or welfare facilities	12	1	7.69%	$
Others	3	0	0.00%	$
Discharge outcome				
Cured	22	0	0.00%	$
Resolved or remission	2342	119	4.84%	
Unchanged or exacerbation	170	15	8.11%	
Others	19	1	5.00%	$
GAF score at admission (function)				
1–20 (danger or hurting self or others)	415	24	5.47%	
21–30 (severely delusional)	1052	47	4.28%	
31–40 (some impairment in reality testing)	519	36	6.49%	
41–60 (moderate or serious symptoms)	440	24	5.17%	
61–100 (generally functioning well)	127	4	3.05%	
Voluntary/Involuntary commitment				
Voluntary commitment	1705	97	5.38%	
Involuntary commitment	848	38	4.29%	
Use of selected psychiatric services				
Complication treatment services [A230]	106	6	5.36%	
Electroconvulsive therapy with anesthesia [I100]	146	5	3.31%	
Selected Elixhauser's comorbidities				
Other neurological disorders	143	13	8.33%	
Hypothyroidism	51	6	10.53%	
Fluid and electrolyte disorders	26	0	0.00%	$
Cardiac arrhythmias	22	3	12.00%	
Chronic pulmonary disease	16	3	15.79%	
Renal failure	8	1	11.11%	$
Rheumatoid arthritis collagen vascular diseases	7	2	22.22%	$
Weight loss	4	1	20.00%	$
LOS categories				
First quartile	561	33	5.56%	
Second and third quartile	1369	69	4.80%	
Fourth quartile	623	33	5.03%	
Hospital factors				
Teaching status				
Academic	1102	56	4.84%	
Not academic	1451	79	5.16%	
Ownership				
Public	1580	76	4.59%	
Private	973	59	5.72%	
pHCI (staffing, function)				
7:1 or 10:1 (high, acute care)	579	21	3.50%	
13:1 (intermediate, mixture of acute and mild/chronic care)	967	65	6.30%	
15:1 (low, mild/chronic care)	1007	49	4.64%	
Psychiatric acute-care beds				
Yes	604	38	5.92%	
No	1949	97	4.74%	
Density of psychiatric beds				
First quartile	591	35	5.59%	
Second and third quartile	1322	70	5.03%	
Fourth quartile	640	30	4.48%	
Density of psychiatrists				
First quartile	668	39	5.52%	
Second and third quartile	1307	76	5.50%	
Fourth quartile	578	20	3.34%	
LOS				
Median	34	33		

(*continued on next page*)

Table 1 (*continued*)

	No-unplanned readmission	unplanned readmission	Proportion of unplanned readmission
IQR	17–56	19–57	
Mean	39.2	39.7	
SD	29.9	27.4	

GAF: Global Assessment of Functioning, LOS: Length of stay, pHCI: psychiatric hospital charge index.
$ Variables which were not included in the logistic regression model due to the number of patients on each category.

initial presentation [28,29]. The result implied that patients in the regions with higher psychiatrist density 1) were diagnosed and treated appropriately compared with patients in the other regions due to more opportunities to see well-skilled specialists and 2) tend to be followed-up by specialists compared with patients in the other regions. This relationship could be related to a previous study's finding that indicated the association between lower risk of readmission and outpatient follow-up care [22,30,31]. Although our statistical model did not include discharge settings because of the number of patients in each category, our study indicated that patients in the regions with lower density of psychiatrists need to be followed-up by well-trained psychiatrists. By contrast, prior research showed an inverse association between inpatient volume per psychiatrist and the 30-day readmission rate of psychiatric inpatients [32]. Further investigation on the relationship between hospital, regional, and psychiatrist characteristics on patient outcome are also essential.

This study has major strengths: it is the largest reported investigation in terms of sample size from Japanese setting using a national administrative database. The study defines outcomes as 30-day unplanned readmission, which excludes planned readmission. It includes hospital and regional factors so that the results are worthy of use for future policy implementation of psychiatric care such as differentiation of psychiatric services including psychiatric healthcare resource allocation.

Several limitations of this study must be considered. First, this investigation was based on administrative database, including data from acute- and mixed-care hospitals, which did not include patients from psychiatric hospitals because data were unavailable. In other words, the study population was not representative of all bipolar disorder patients in Japan. Psychiatric hospitals account for approximately 250,000 beds while acute- and mixed-care hospitals account for approximately 88,000 beds. The present study covered 10,000 beds, comprising only 3% of overall psychiatric beds, which could have resulted in selection bias. However, psychiatric patients in acute-/mixed-care hospitals contribute to cost of burden due to more chronic conditions or severities. In general, acute-care hospitals included psychiatric patients with medical/physical comorbidities while psychiatric hospitals did not usually provide inpatient services to these patients. Further analyses are needed for enhancing the generalizability of our results.

Second, the study only captured unplanned readmissions to the same hospital: readmissions to the other hospitals were not captured due to the data unavailability. Although it is said that bipolar disorder patients tend to be treated in the same hospital, this was a potential source of underestimation, especially in areas with multiple hospitals. The study evaluated only short-term outcomes; long-term outcomes such as 90-day unplanned readmission and 1-year unplanned

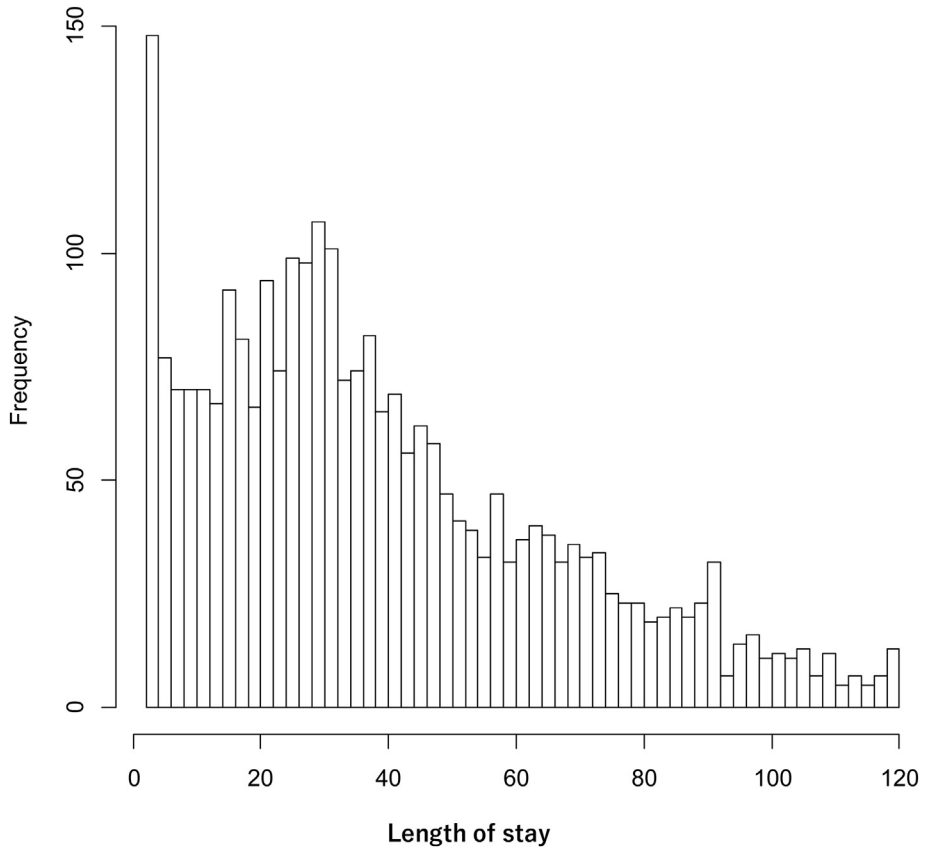

Fig. 2. Histogram of length of stay for the study cohort.

Table 2
Logistic regression model for 30-day unplanned readmission for Bipolar disorder patients.

Variables	OR, unadjusted	p, unadjusted	OR, adjusted	OR, 95% lower	OR, 95% upper	p, adjusted
Patient factors						
Age group (years)						
15–29	Reference					
30–29	0.72	0.090	0.67	0.36	1.23	0.199
50–64	1.46	0.037	1.15	0.63	2.08	0.648
65 and over	0.81	0.324	0.77	0.40	1.48	0.430
Sex						
Male	Reference					
Female	0.86	0.420	0.84	0.59	1.21	0.355
Use of ambulance	1.23	0.610	1.17	0.51	2.69	0.714
Admission settings						
Planned	Reference					
Unplanned or urgent	1.40	0.061	1.51	1.00	2.26	0.048
Discharge outcome						
Resolved or remission	Reference					
Unchanged or exacerbation	1.75	0.049	1.93	1.06	3.51	0.031
GAF score at admission (function)						
1–20 (danger or hurting self or others)	1.11	0.641	1.88	0.61	5.78	0.268
21–30 (severely delusional)	0.76	0.142	1.43	0.49	4.12	0.512
31–40 (some impairment in reality testing)	1.43	0.078	2.16	0.74	6.31	0.158
41–60 (moderate or serious symptoms)	1.04	0.871	1.90	0.63	5.72	0.253
61–100 (generally functioning well)	Reference					
Voluntary/involuntary commitment						
Voluntary commitment	Reference					
Involuntary commitment	0.79	0.223	0.67	0.43	1.06	0.089
Use of selected psychiatric services						
Complication treatment services [A230]	1.07	0.868	0.96	0.40	2.30	0.929
Electroconvulsive therapy with anesthesia [I100]	0.63	0.326	0.78	0.31	2.00	0.612
Selected Elixhauser's comorbidities						
Other neurological disorders	1.80	0.054	1.71	0.91	3.20	0.095
Hypothyroidism	2.28	0.061	2.15	0.87	5.31	0.098
Cardiac arrhythmias	2.61	0.122	1.91	0.54	6.83	0.317
Chronic pulmonary disease	3.60	0.044	4.74	1.30	17.29	0.018
LOS categories						
First quartile	1.15	0.500	1.01	0.64	1.61	0.952
Second and third quartile	Reference					
Fourth quartile	1.00	0.991	1.17	0.75	1.83	0.484
Hospital factors						
Teaching status						
Academic	0.93	0.700	1.50	0.92	2.44	0.102
Not academic	Reference					
Ownership						
Public	0.79	0.194	0.76	0.52	1.13	0.176
Private	Reference					
pHCI (staffing, function)						
7:1 or 10:1 (high, acute care)	0.63	0.055	0.95	0.50	1.79	0.873
13:1 (intermediate, mixture of acute and mild/chronic care)	1.52	0.017	1.82	1.14	2.91	0.012
15:1 (low, mild/chronic care)	Reference					
Psychiatric acute-care beds						
Yes	1.26	0.234	1.72	1.02	2.87	0.040
No	Reference					
Density of psychiatric beds						
First quartile	1.16	0.457	1.26	0.79	2.00	0.333
Second and third quartile	Reference					
Fourth quartile	0.85	0.457	1.10	0.68	1.76	0.704
Density of psychiatrists						
First quartile	1.15	0.484	0.94	0.59	1.50	0.795
Second and third quartile	Reference					
Fourth quartile	0.59	0.035	0.50	0.29	0.87	0.014
AUC			0.672			

AUC: Area Under the Curve, GAF: Global Assessment of Functioning, LOS: Length of stay, pHCI: psychiatric hospital charge index.
*Following variables were not included due to the number of patients on each category.
Discharge settings (all of variables), Discharge outcome (Cured, Others), Elixhauser's comorbidities (Renal failure, Rheumatoid arthritis collagen vascular diseases, Weight loss, Fluid and electrolyte disorders).

readmission were not investigated.

Third, there could have been residual confounding associated with risk of early unplanned readmission due to unmeasured factors such as outpatient follow-up visit and prior hospitalizations [22,30,31], socio-economic factors (education, income, employment etc.) [22], family status [22], pharmacological treatments [33,34], and use of welfare services.

Fourth, we believe most patients were discharged as they reach their treatment endpoint; however, some of them might not be discharged for other reasons including family circumstance. We believe the criteria for rehospitalization was based on the patient's need of psychiatric inpatient care, but it is not clear whether other factors such as bed occupancy of hospitals affected the rehospitalization criteria.

Fifth, the multivariate logistic regression model includes exceeded

number of variables in terms of sample size consideration according to the study of Peduzzi et al [35]. Sample size calculation for logistic regression is a complex problem. Variables considered in this study were typical and essential meanwhile such models with excessive variables tend to be unstable. Thus, the results could partly be unstable though we had checked the model carefully and the results of 95% CIs were relatively reasonable.

5. Conclusions

In summary, using a national database of acute- and mixed-care hospitals, we investigated factors associated with early unplanned readmission in patients with bipolar disorders in Japan. Interventions for high-risk patients need to be taken into consideration. Although our study did not cover patients from psychiatric hospitals, our findings indicated the need to consider functional differences in psychiatric inpatient care, psychiatric resource allocation, and follow-up support in patients with bipolar disorder for reducing the early unplanned readmission rate. Further studies for achieving quality improvement, efficiency, and accessibility in psychiatric services are strongly required.

Funding

This study was supported by a Grant-in-Aid for Young Scientists (B) from the Japan Society for the Promotion of Science, Japan (JSPS KAKENHI, Grant Number 16K19284), and a Grant-in-Aid for Research on Policy Planning and Evaluation from the Ministry of Health, Labour and Welfare, Japan (H28-Seisaku-Shitei-009).

Acknowledgement

We wish to express our gratitude to everyone in the National Center of Child Health and development, and Tokyo Medical and Dental University for their cooperation. Special thanks are also due to Takahiro Miki, National Center of Child Health and Development, for his valuable insights and support.

Conflict of interest

The authors declare that they have no conflict of interest.

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