Mortality and rehospitalization rates among patients with severe mental illness (SMI) at different levels of hospital spending

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Abstract

Background

Evidence has shown that the relationships between hospital spending and treatment outcomes for physical conditions have been inconclusive. So to investigate the association between hospital spending and both risk-adjusted mortality and rehospitalization rates among patients with severe mental illness (SMI).

Method

This was a retrospective cohort study that used the Taiwan National Health Research Institute Database (NHRID) from 1999 to 2010. Hospital end-of-life (EOL) spending was used to quantify hospital spending and was determined by the total medical costs of the last year of life of patients with at least one previous psychiatric hospitalization. Patients with schizophrenia (n=13,229), bipolar disorder (n=4,476) and major depressive disorder (n=5,177) were followed for mortality and rehospitalization to psychiatric wards from 2009 to 2010 after they had been discharged from the study hospitals.

Results

Patients with schizophrenia had lower rehospitalization and mortality rates when treated at higher-spending hospitals than when treated at the lowest-spending hospitals. However, these associations became weak, even nonsignificant, when adjusted for patient-level variables. There were no significant findings for patients with bipolar disorder and major depressive disorder when patient-level variables were adjusted for. Patient-level variables showed more determinant roles than hospital-level variables in the relationships between hospital spending and treatment outcomes.

Conclusion

Hospitals that spend more at the EOL had lower mortality and rehospitalization rates for patients with schizophrenia but higher rates for bipolar disorder and major depressive disorder. Most of these associations could be explained by patients’ characteristics more than hospitals’ characteristics.

Background

As the costs of medical care gradually increase, an increasing number of studies have been devoted to investigating the relationship between treatment outcomes and hospital spending (Fisher, Wennberg, & StUKEL, 2003a, 2003b;Romley, Jean, & Goldman, 2011Silber, Kaestner, & Even-Shoshan, 2010Barnato, Chang, & Farrell, 2010Goodman, Fisher, & Little, 2002Skinner, Staiger, & Fisher, 2006Martin, Rice, & Smith, 2008Chen, Jha, & Guterman, 2010Landrum, Meara, & Chandra, 2008Yasaitis, Fisher, & Skinner, 2009Rothberg, Cohen, & Lindenauer, 2010Stukel, Fisher, & Alter, 2012). However, the results have been controversial. Some studies have revealed positive results (Romley et al., 2011Silber et al., 2010Barnato et al., 2010Martin et al., 2008Stukel et al., 2012). For example (Romley et al., 2011), found that patients

admitted to higher-spending hospitals in a regional area were associated with lower risk-adjusted inpatient mortality for six major acute medical conditions. The association between hospital spending and inpatient mortality did not vary by geographic region or hospital size. They pointed out that specific types of medical spending, e.g., acute-care hospital spending, may be efficacious. A recent population-based, longitudinal study also showed that higher spending intensity was associated with lower mortality, lower readmission rates and better quality of care for 4 common conditions(Stukel et al., 2012). The study revealed that higher-spending hospitals had higher nursing staff ratios, more inpatient medical specialist visits, more specialty care and more postdischarge collaborative care. However, some studies have not shown these positive results (Fisher et al., 2003a, 2003b、Chen et al., 2010、Landrum et al., 2008、Yasaitis et al., 2009、Rothberg et al., 2010、Wennberg, Fisher, & Stukel, 2004、Wennberg, Fisher, & Baker, 2005、Wennberg, Fisher, & Sharp, 2005). In a large inpatient database study, the authors studied the correlation between the degree of increase in health cost and the degree of decrease in mortality for 7 physical illnesses. They found that health care spending grew over time, but there was little evidence of an association with decreases in mortality(Rothberg et al., 2010). In Chen et al.'s study, they also revealed that the relationship between a hospital's cost of care and the process quality of care was small and inconsistent among patients with congestive heart failure (CHF) and pneumonia. The relationship was also variable across conditions. They pointed out higher-spending hospitals have poor quality of care scores in the treatment of CHF and poor mortality rates in the treatment of pneumonia(Chen et al., 2010). However, the findings are conflicting, and more studies are needed to provide additional evidence to clarify these discrepancies. In addition, all these previous studies have focused on physical illnesses, and there is a lack of evidence related to psychiatric illnesses. Therefore, we conducted this study to investigate the relationship between hospital spending and treatment outcomes, including mortality and rehospitalization rates, among patients with severe mental illness (SMI).

Method

Availability of data and materials: The National Health Research Institute Database (NHRID)

In 1995, Taiwan implemented a government-run, universal, mandatory-enrollment, single-payer insurance system, the National Health Insurance (NHI) program. It covered 99% of the Taiwanese population and contracted with 97% of the medical service providers (Tsai, Lee, & Chou, 2012). The International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) was used for diagnostic coding of the Taiwanese Bureau of National Health Insurance (BNHI). The BNHI released medical service data as an anonymous public database for research called the National Health Research Institute Database (NHRID). The NHRID consists of ambulatory card records, inpatient card records and the registration files of the insured. The completeness and accuracy of NHRID has been confirmed by the Taiwan Department of Health and the BNHI through audit (Bai, Su, & Chen, 2013). The BNHI of Taiwan randomly reviews the charts of 1 out of every 100 ambulatory cases and 1 out of every 20 inpatient cases and interviews patients to verify the accuracy of the diagnosis. This study was approved by the Institutional Review Board of Kaohsiung Municipal Kai-Syuan Psychiatric Hospital, Taiwan (Ethical code: KSPH 102031). Review board requirements for written informed consent were waived because all personal identifying

information had been removed from the dataset prior to analysis. The data used in this study were from the NHRID from 1999 to 2010.

Hospital spending

The primary independent variable was hospital end-of-life (EOL) spending. EOL spending was thought to be reflective of the hospital spending pattern and physician practice style to all patients admitted to that hospital (Stukel et al., 2012) because the patients had identical life expectancy and were not thought to be different in severity of illness(Fisher et al., 2003a). EOL spending has also been proven to be highly related to hospital's acute-care expenditure, so it could be used as a hospital treatment intensity measure to assess eventual outcomes (Stukel et al., 2012). The authors selected all decedents from the NHRID between January 1st, 2009, to December 31st, 2010, and then only enrolled decedents who had at least one psychiatric hospitalization with a psychiatric diagnosis (ICD-9-CM codes 290 to 319) from the NHRID data from 1999 to 2010. We confined the selected decedents to those treated for their illnesses, both physical and psychiatric conditions, at the same hospital in their last year of life. If the patients visited more than one hospital, they were excluded. However, if the patients visited a psychiatric department of another hospital only once or they received psychiatric consultations at other hospitals when they were hospitalized for physical illness, they would still be assigned to the original hospital in which they were treated over the last year of life. Then, we used the NHRID database from 2009 to 2010 to calculate the total medical spending in their last year of life (EOL spending) as the measure of hospital spending. There were 3194 decedents referred to 259 hospitals fitting our inclusion criteria and enrolled in our study. We divided the hospital spending of the enrolled hospitals into three equal parts: high, moderate, and low hospital spending. However, after we enrolled the study cohorts, there were 90 hospitals without study patients because these hospitals only provided outpatient services and day care treatment. They did not have an acute psychiatric ward to provide hospitalization treatment. Finally, 169 hospitals remained in our study in the high (n = 56), moderate (n = 68) and low (n = 45) hospital spending groups.

Study cohorts and primary measurements

Study patients were those who had received hospitalization treatment for their psychiatric illnesses at the enrolled hospitals with diagnoses of schizophrenia (ICD-9-CM 295.XX), bipolar disorder (BPD) (ICD-9-CM 296.0X, 296.1X, 296.4X ~ 296.8X) and major depressive disorder (MDD) (ICD-9-CM 296.2X, 296.3X) and discharged from January 1st, 2009, to December 31st, 2009. We followed these patients to determine rates of mortality and rehospitalization to the psychiatric ward from the day they discharged until December 31st, 2010. Therefore, every patient was followed for at least 1 year, and up to a maximum of 2 years.

Covariables

We linked the discharged study cohort to hospital- and patient-level data. Hospital-level covariables were hospital level (e.g., medical center, regional hospital or district hospital), ownership (public, private or foundation), location (north, central, south or east Taiwan), teaching hospital (teaching hospital for

resident physicians), and psychiatric specialty hospital. Patient-level covariables were age, sex, alcohol use disorder, substance use disorder, hypertension, diabetes, hyperlipidemia, physical comorbidities (based on Charlson Comorbidity Index (CCI) scores) (Deyo, Cherkin, & Ciol, 1992), enrollee category (EC), and level of urbanization. The participants of the NHI in Taiwan were classified into four subgroups: EC1 (civil servants, full-time or regular paid personnel with a government affiliation), EC2 (employees of privately owned institutions), EC3 (self-employed individuals, other employees and members of the farmers' or fishermen's association), and EC4 (veterans, members of low-income families, and substitute service draftees) (Chen, Liu, & Su, 2007). EC, as a proxy measure of socioeconomic status, is an important factor for the prognosis of psychiatric illnesses (Hudson, 2005).

The urbanization level was a potential risk factor for psychiatric disorders and had also been identified as a risk indicator for psychiatric admission(Peen, & Dekker, 2003). We used the criteria published by the Taiwanese National Health Research Institute for urbanization levels in Taiwan, which were determined by the population density, percentage of residents with a college education or higher, percentage of residents more than 65 years of age, percentage of residents who were agriculture workers, and number of physicians per 100,000 individuals. The urbanization level was divided into urban, suburban, and rural settings (Chou, Tsai, & Chou, 2013).

The comorbidity of each patient was based on the CCI score, which has been widely used for risk adjustment in insurance claims datasets. We modified the CCI by calculating the sum of the weighted scores based on the relative mortality risk for 19 conditions(Deyo et al., 1992). The physical illness information was extracted from the NHRID data from 1999 to 2010. In addition, diabetes, hypertension, hyperlipidemia, alcohol use disorder and substance use disorder have been reported to be associated with the treatment and prognosis of SMI (Bouza, López-Cuadrado, & Amate, 2010). Therefore, these illnesses were treated as important factors in this study. The diagnosis codes of medical comorbidities and alcohol and substance use disorders were based on the ICD-9-CM codes in the Elixhauser Comorbidity Index (Quan, Sundararajan, & Halfon, 2005).

Statistics

Demographic and clinical characteristics were analyzed by using $\chi 2$ tests for categorical variables and t tests for continuous variables. Survival analysis with the Cox proportional hazard model was used to calculate the hazard ratios (HRs) and 95% confidence intervals (CIs) for mortality and rehospitalization rates among the different hospital-spending groups. Different models were used to adjust different covariables, so we could explore the influence of different covariables. Model 1 was used for total covariables (overall). Model 2 was used to adjust for hospital-level variables only, and Model 3 was used to adjust for patient-level variables only. All statistical tests were two-sided, and the significance level was set at 0.05. All data were linked and analyzed using SAS software, version 8.2.

Results

The group of high-spending hospitals contained more of the medical centers (30.4% of the high-spending hospitals vs. 2.9% and 0% of the moderate- and low-spending hospitals, respectively), more of the teaching hospitals (87.5%) and, of course, many more of the nonpsychiatric specialty hospitals (98.2%) (Table 1). It was understandable that the NHI program pays more for the same treatment items to medical centers, which were followed by regional hospitals and then district hospitals, because the manpower of the medical staff, equipment and setting of the medical centers have been established to achieve higher standards.

Table 1
The characteristics of hospitals with different levels of hospital spending.

	Hospitals (n = 169)						
Hospital spending	Low		Moderate		High		P
	n	%	n	%	n	%	
	45	26.6	68	40.2	56	33.1	
EOL spending (NT$)							
Mean (SD)	28,852	(11,799)	65,729	(9,230)	12,3142	(40,707)	
Hospital level							< .001
Medical center	0	0	2	2.9	17	30.4	
Regional	12	26.7	37	54.4	27	48.2	
District	33	73.3	29	42.7	12	21.4	
Teaching hospital							< .001
Yes	14	31.1	46	67.7	49	87.5	
No	31	68.9	22	32.4	7	12.5	
Ownership							.506
Public	19	42.2	26	38.2	22	39.3	
Private	14	31.1	15	22.1	11	19.6	
Foundation	12	26.7	27	39.7	23	41.1	
Location							.846
North	14	31.1	20	29.4	23	41.1	
Central	14	31.1	20	29.4	14	25.0	
South	15	33.3	23	33.8	15	26.8	
East	2	4.4	5	7.4	4	7.1	

	Hospitals (n = 169)						
Psychiatric specialty hospital							< .001
Yes	18	40.0	7	10.3	1	1.8	
No	27	60.0	61	89.7	55	98.2	

1. Schizophrenia patients

Table 2 shows the demographic and clinical characteristics of the study patients. There were 13,229 schizophrenia patients enrolled in this study, including 3,776 in the low hospital-spending group, 4,152 in the moderate hospital-spending group and 5,301 in the high hospital-spending group. The high-spending group also had the significantly lowest rates of alcohol use disorder (3.2% vs. 4.1% and 4.3% for the high-, moderate- and low-spending groups, respectively). However, there were no significant differences in the rates of substance use disorder between the hospital-spending groups. The high-spending group had the lowest CCI scores and accounted for the lowest physical illness comorbidities, including diabetes mellitus (DM), hypertension (HTN) and hyperlipidemia. These characteristics might have indicated that schizophrenia patients in the high-spending group were less complicated with regards to illness severity. There were more patients in the high-spending group living in urban or suburban areas.

Table 2

Demographic and clinical characteristics of the study cohort

	Schizophrenia (n = 13,229)			**Bipolar disorder (n = 4,476)**			**Major depressive disorder (n = 5,177)**		
Hospital spending	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
	N = 3,776	n = 4,152	n = 5,301	n = 897	n = 1,079	n = 2,500	n = 1,640	n = 1,010	n = 2,527
Mean (SD)									
Age	42.4 (12.6)	40.8 (11.8)	39.7 (12.1)**	41.4 (14.1)	42.8 (13.7)	41.8 (14.3)	33.1 (14.7)	46.1 (15.7)	45.3 (15.6)**
CCI_score (SD)	.23 (.742)	.23 (.760)	.19 (.748)*	.21 (.70)	.35 (.85)	.30 (.78)**	.22 (.80)	.61 (1.31)	.44 (1.13)**
No. (%)									
Sex									
Female	1,551 (41.1)	1,760 (42.4)	2,618 (49.4)	428 (47.7)	547 (50.7)	1,462 (58.5)	515 (31.4)	550 (54.5)	1,565 (61.9)
Male	2,225 (58.9)	2,392 (57.6)	2,683 (50.6)	469 (52.3)	532 (49.3)	1,038 (41.5)**	1,125 (68.6)	460 (45.5)	962 (38.1)**
Alcohol use disorder									
Yes	164 (4.3)	169 (4.1)	172 (3.2)*	59 (6.6)	99 (9.2)	177 (7.1)*	148 (9.0)	177 (17.5)	326 (12.9)**
Substance use disorder									
Yes	65 (1.7)	59 (1.4)	97 (1.8)	20 (2.2)	20 (1.9)	64 (2.6)	50 (3.0)	36 (3.6)	92 (3.6)
DM									
Yes	352 (9.3)	362 (8.7)	400 (7.5)*	71 (7.9)	133 (12.3)	286 (11.4)*	69 (4.2)	132 (13.1)	277 (11.0)**
HTN									
Yes	434 (11.5)	431 (10.4)	490 (9.2)*	106 (11.8)	166 (15.4)	338 (13.5)	105 (6.4)	229 (22.7)	464 (18.4)**
Hyperlipidemia									
Yes	165 (4.4)	179 (4.3)	219 (4.1)	28 (3.1)	63 (5.8)	176 (7.0)**	48 (2.9)	69 (6.8)	214 (8.5)**
Enrollee category									
Category 1	83 (2.2)	105 (2.5)	197 (3.7)	48 (5.4)	51 (4.7)	130 (5.2)	62 (3.8)	47 (4.7)	128 (5.1)
Category 2	438 (11.6)	491 (11.8)	791 (14.9)	153 (17.1)	188 (17.4)	485 (19.4)	434 (26.5)	153 (15.1)	468 (18.5)
Category 3	665 (17.6)	979 (23.6)	1,070 (20.2)	232 (25.9)	375 (34.8)	709 (28.4)	332 (20.2)	320 (31.7)	741 (29.3)
Category 4	2,590 (68.6)	2,577 (62.1)	3,243 (61.2)**	464 (51.7)	465 (43.1)	1,176 (47.0)**	812 (49.5)	490 (48.5)	1,190 (47.1)**
Urbanization of patients' residential area									

*: P < 0.05

**: P < 0.001

	Schizophrenia (n = 13,229)			Bipolar disorder (n = 4,476)			Major depressive disorder (n = 5,177)		
Urban	2,038 (54.0)	1,887 (45.4)	3,680 (69.4)	544 (60.6)	568 (52.6)	1,821 (72.8)	1,131 (69.0)	507 (50.2)	1,869 (74.0)
Suburban	1,128 (29.9)	1,562 (37.6)	1,207 (22.8)	257 (28.7)	370 (34.3)	531 (21.2)	401 (24.5)	376 (37.2)	496 (19.6)
Rural	610 (16.2)	703 (16.9)	414 (7.8)**	96 (10.7)	141 (13.1)	148 (5.9)**	108 (6.6)	127 (12.6)	162 (6.4)**
Hospital level									
Medical center	0 (0)	109 (2.6)	2,282 (43.0)	0 (0)	50 (4.6)	1,350 (54.0)	0 (0)	50 (5.0)	1,436 (56.8)
Regional hospital	2,108 (55.8)	2,309 (55.6)	2,812 (53.0)	576 (64.2)	643 (59.6)	1,069 (42.8)	1,317 (80.3)	637 (63.1)	973 (38.5)
District hospital	1,668 (44.2)	1,734 (41.8)	207 (3.9)**	321 (35.8)	386 (35.8)	81 (3.2)**	323 (19.7)	323 (32.0)	118 (4.7)**
Hospital ownership									
Public	2,447 (64.8)	2,349 (56.6)	3,318 (62.6)	587 (65.4)	518 (48.0)	1,505 (60.2)	1,311 (79.9)	429 (42.5)	1,479 (58.5)
Private	674 (17.8)	537 (12.9)	387 (7.3)	188 (21.0)	134 (12.4)	203 (8.1)	155 (9.5)	65 (6.4)	222 (8.8)
Foundation	655 (17.3)	1,266 (30.5)	1,596 (30.1)**	122 (13.6)	427 (39.6)	792 (31.7)**	174 (10.6)	516 (51.1)	826 (32.7)**
Hospital location									
North	1,227 (32.5)	1,022 (24.6)	2,716 (51.2)	299 (33.3)	317 (29.4)	1,348 (53.9)	854 (52.1)	254 (25.1)	1,231 (48.7)
Central	938 (24.8)	1,153 (27.8)	1,064 (20.1)	289 (32.2)	327 (30.3)	421 (16.8)	336 (20.5)	250 (24.8)	308 (12.2)
South	1,162 (30.8)	1,491 (35.9)	1,281 (24.2)	283 (31.5)	377 (34.9)	594 (23.8)	433 (26.4)	396 (39.2)	794 (31.4)
East	449 (11.9)	486 (11.7)	240 (4.5)**	26 (2.9)	58 (5.4)	137 (5.5)**	17 (1.0)	110 (10.9)	194 (7.7)**
Teaching hospital									
Yes	2,150 (56.9)	2,611 (62.9)	5,147 (97.1)**	593 (66.1)	763 (70.7)	2,428 (97.1)**	1,321 (80.5)	749 (74.2)	2,416 (95.1)**
Psychiatric specialty hospital									
Yes	2,895 (76.7)	1,261 (30.4)	48 (.9)**	742 (82.7)	300 (27.8)	18 (.7)**	1,322 (80.6)	135 (13.4)	8 (.3)**
*: P < 0.05									
**: P < 0.001									

Among schizophrenia patients, the rehospitalization rates and mortality rates were diminished by hospital spending (Table 3). There were 10% and 15% reductions in rehospitalization rates and approximately 27% and 37% reductions in mortality rates in the moderate- and high-spending groups, respectively, compared with the low-spending group (Model 1). When we adjusted for hospital variables, these trends seemed persistent (Model 2). However, these trends disappeared, and the differences between groups became almost nonsignificant after adjusting for patient variables.

Table 3

Cox regression of rehospitalization and mortality rates across diagnoses and different levels of hospital spending

	Hospital spending				
	Low	Moderate		High	
Schizophrenia					
Rehospitalization		Exp (β)	95% CI	Exp (β)	95% CI
Model 1	Reference	.897*	.838 ~ .960	.852**	.782 ~ .929
Model 2		.874**	.817 ~ .935	.823**	.756 ~ .896
Model 3		1.002	.945 ~ 1.062	.926*	.876 ~ .979
Mortality rate					
Model 1	Reference	.726*	.535 ~ .986	.632*	.428 ~ .932
Model 2		.669*	.494 ~ .906	.561*	.382 ~ .824
Model 3		.824	.631 ~ 1.077	.809	.623 ~ 1.051
Bipolar disorder					
Rehospitalization					
Model 1	Reference	1.006	.881 ~ 1.148	.948	.816 ~ 1.102
Model 2		1.028	.902 ~ 1.171	.943	.813 ~ 1.093
Model 3		1.091	.976 ~ 1.220	.903	.818 ~ .996
Mortality rate					
Model 1	Reference	1.642	.855 ~ 3.153	1.567	.738 ~ 3.331
Model 2		1.625	.864 ~ 3.056	1.584	.763 ~ 3.289
Model 3		1.311	.754 ~ 2.280	.973	.584 ~ 1.624
MDD					
Rehospitalization					
Model 1	Reference	1.098	.956 ~ 1.262	1.257*	1.088 ~ 1.453
Model 2		1.360**	1.188 ~ 1.557	1.608**	1.398 ~ 1.849
Model 3		1.207*	1.082 ~ 1.347	1.085	.989 ~ 1.191
Mortality rate					
Model 1	Reference	1.209	.696 ~ 2.100	.867	.474 ~ 1.586
Model 2		1.966*	1.176 ~ 3.289	1.272	.727 ~ 2.226
Model 3		1.499	.989 ~ 2.272	1.118	.760 ~ 1.643
*: P < 0.05					
**: P < 0.001					
Model 1: adjusted for hospital variables and patient variables.					
Model 2: adjusted for hospital variables only					
Model 3: adjusted for patient variables only					
Hospital variables (hospital level, ownership, location, teaching hospital, psychiatry specialty hospital)					
Patient variables (age, sex, CCI scores, alcohol use disorder, substance use disorder, DM, HTN, hyperlipidemia, enrollee category, urbanization of patients' residential area)					

2. BPD patients

There were 4476 BPD patients enrolled in this study, including 897 in the low hospital-spending group, 1,079 in the moderate hospital-spending group and 2,500 in the high hospital-spending group. The moderate-spending group had significantly higher rates of alcohol use disorder (9.2% vs. 7.1% and 6.6% for the moderate-, high- and low-spending groups, respectively). However, there were no significant differences in the rates of substance use disorder between the hospital-spending groups. The moderate-spending group had the highest CCI scores and accounted for the highest physical illness comorbidity, including DM and HTN, followed by the high-spending group and finally the low-spending group. However, the high-spending group showed the highest rates of hyperlipidemia. There were significantly more patients in the high-spending group living in urban areas.

The rehospitalization rates and mortality rates in BPD patients did not show significant differences among groups, regardless of whether hospital variables or patient variables were adjusted for.

3. MDD patients

There were 5,177 MDD patients enrolled in this study, including 1,640 in the low hospital-spending group, 1,010 in the moderate hospital-spending group and 2,527 in the high hospital-spending group. Similar to the BPD patients, the moderate-spending group of MDD patients had significantly higher rates of alcohol use disorder (17.5% vs. 12.9% and 9.0% for the moderate-, high- and low-spending groups, respectively), which were much higher than those in the schizophrenia and BPD patients. There was no significant difference in the rates of substance use disorder between the hospital-spending groups. Regarding physical illness comorbidity, the pattern among the MDD patients showed the same trend as that of the BPD patients. The moderate-spending group had the highest CCI scores and highest physical illness comorbidity, including DM and HTN, followed by the high-spending group and finally the low-spending group. The high-spending group showed the highest rates of hyperlipidemia. The patients in the high-spending group were also significantly more likely to live in urban areas.

In MDD patients, the high-spending group showed significantly higher rehospitalization rates than the low-spending group but did not show significantly higher mortality rates using Model 1. When hospital variables were adjusted for, the moderate- and high-spending groups both showed significantly higher rehospitalization rates than the low-spending group, up to 36% and 61% higher, respectively. There was a significantly higher mortality rate of up to 97% in the moderate-spending group than the low-spending group after adjusting for hospital variables. There were no other significant differences in mortality rates among the groups.

Discussion

The strengths of this study were that it had a large sample, was population-based and focused on SMI. We found that greater hospital spending was associated with lower rehospitalization and lower mortality rates in schizophrenia patients, but this relationship was not observed in BPD or MDD patients. Moreover, higher-spending hospitals were associated with poor rehospitalization and mortality outcomes in BPD and MDD patients. The results were conflicting. In patients with schizophrenia, the positive results were similar to previous studies focusing on physical illnesses(Romley et al., 2011;Silber et al., 2010Barnato et al., 2010Goodman et al., 2002Stukel et al., 2012), and according to previous studies, the possible explanation might be due to more critical care staff, skilled nursing, more intensive inpatient specialist services, more costly intensive interventions (for example, coronary revascularization for acute myocardial infarction or endoscopies for gastrointestinal hemorrhages), high technology, specialized programs, greater use of evidence-based care, etc(Stukel et al., 2012Lee, Stukel, & Austin, 2010). It was understandable that most high-spending hospitals in our study were medical centers or regional hospitals and that they might have more sufficient medical staff, more specialist physicians and more expensive high-tech tests and interventions, so that they might provide better services. Previous work had also revealed that higher spending was associated with care of a higher treatment intensity(Fisher et al., 2011b). However, another explanation might be due to patient selection because these positive results disappeared when patient-level variables were adjusted for, and these results remained when hospital-

level variables were adjusted for. These findings might indicate that the main factors explaining these results were due to the patients themselves, not the hospitals. We observed that the schizophrenia patient group in the high-spending hospitals had more females, the lowest CCI scores, and the lowest rates of DM, HTN, hyperlipidemia and alcohol use disorder. This finding might imply that the schizophrenia patients in the high-spending hospitals might be a group of patients with a better prognosis for treatment(Lehman, Lieberman, & Dixon, 2010).

However, we did not have data regarding the assessment of the severity of the psychiatric symptoms. More studies are needed to clarify this issue. However, the BPD patients and MDD patients in the moderate- and high-spending groups did not show better treatment outcomes than the low-spending groups. We also found that the BPD and MDD patients in the moderate- and high-spending groups had a greater number of poor prognosis factors, such as a higher proportion of females, were older, had higher CCI scores with more physical comorbidities, and had more alcohol and substance use disorders(Sadock, Sadock, & Ruiz, 2015). This might have reflected a bias of patient selection. The healthier patients might have sought treatment at low-spending hospitals because they thought their mental illnesses were less severe; however, when their illnesses worsened or they felt sicker, they might have been transferred to higher-spending hospitals or visited higher-spending hospitals on their own because the higher-spending hospitals (mostly the medical centers or regional hospitals) were generally considered to have better medical staff manpower, better settings and better performance. Romley et al. also suggested this type of patient selection in their work(Romley et al., 2011).

Moreover, the MDD patients had worse outcomes in the moderate- and high-spending hospitals than in the low-spending hospitals. This finding went completely against our expectation that the more a hospital spent on treatment, the better the outcome would be. MDD patients were generally more anxious and sensitive to mental and physical problems. They might have actively requested more medical exams or treatment, or they might have shifted to treatment in medical centers, i.e., the high-spending hospitals, if they felt worse. On the other hand, schizophrenia patients had more severe cognition deterioration. They often neglected their problems or treatment and even refused additional treatment. In addition to patients with poor prognosis characteristics, differences in outcomes might have been due to treatment patterns. For physical conditions, higher-spending hospitals might have used intensive medical care, which is correlated with spending, instead of less expensive and simpler proven medical interventions (Baicker, & Chandra, 2004). However, some studies have shown that higher spending was associated with lower quality as measured by performance on process-of-care measures(Fisher et al., 2003;Chen et al., 2010Yasaitis et al., 2009) and did not improve the outcomes(Rothberg et al., 2010). Low-spending hospitals may have included more efficient organizations that require less money (Chen et al., 2010). Although we cannot identify this phenomenon from our data, our results might imply that patients at low-spending hospitals might receive appropriate care for specific conditions.

Another explanation might be the payment system of the NHI program. The NHI program paid more to medical centers for the same treatment items under the premise that medical centers used a larger medical staff and had more sufficient settings and equipment to provide better services, followed by

regional hospitals and district hospitals. For example, NT$ 393, 371 and 334 were paid for physician fees, and NT$ 730, 644 and 605 were paid for nursing fees for medical centers, regional hospitals and district hospitals, respectively. Hospitals should be audited to obtain their qualifications as medical centers, regional hospitals or district hospitals based on their medical staff manpower, settings, equipment, services and performance. Therefore, patients might have received exactly the same treatment items and the same treatment dosage but with a difference in costs simply because the hospital levels were different. However, to own their professional certificate, all medical staff who performed the treatments were qualified by the Ministry of Health and Welfare. That is, the treatments at medical centers did not promise better treatment qualifications or better treatment outcomes. Although medical centers had some advantages, it was difficult to evaluate the quality of the treatment itself, especially for psychosocial treatment in psychiatry. Huhn et al. also pointed out that there was no useful scale to assess psychosocial treatment (Huhn, Tardy, & Spineli, 2014). In psychiatric treatment, medical costs were mainly classified into four categories: fees for drug therapy, psychosocial treatment, beds and examinations. In addition to psychosocial treatment and the examination discussed above, drug therapy was a large issue. New psychotropic agents, including second generation antipsychotics (SGA), newer antidepressants and newer mood stabilizers, have been much more expensive than the traditional agents, but the newer agents have not proven to be more effective than the traditional agents(Sampford, Sampson, & Li, 2016;Saha, Bo, & Zhao, 2016Bauer, Severus, & Möller, 2017). If a hospital used the more expensive newer drugs, it did not promise a better outcome but this would result in large increases in hospital spending. However, we did not have data on hospital spending on drug therapy between high- and low-spending hospitals. We could not obtain any conclusions on this issue. However, it is an important issue worthy of further investigation.

Limitation

To our knowledge, this was the first study of mental illnesses focusing on the relationships of hospital spending and treatment outcomes with large sample using population-based data. However, there were still some limitations. First, hospital spending was determined by total medical costs of EOL treatment, not disease-specific costs, which might lead to bias when categorizing hospital spending because costs in psychiatric treatment were much different from costs in physical illnesses. The hospital spending at the EOL, which was mostly used in the treatment of physical conditions, might not be representative of hospital spending for mental illnesses, although EOL spending has been shown to be highly correlated with both total medical care spending and spending for specific diseases(Fisher, Wennberg, & Stukel, 2004). Chen et al. also showed there was no, or at least not much, change in the relationship between cost of care and process quality of care or between cost of care and mortality assessed by using disease-specific costs of care instead of total hospital costs of care(Chen et al., 2010). Second, to categorize the level of hospital spending more specifically, we only included hospitals with patients who received treatment for their last year of life at the same hospitals. Thus, the number of hospitals enrolled in this study were reduced. In addition, we only followed the hospitalized patients with these three SMIs. Many hospitals without hospitalization services for mentally ill patients were excluded. This limits the generalization of the study results and has limited applicability to outpatients. Third, the

rehospitalizations of mentally ill patients were affected by many factors, such as outpatient services, home treatment, case management, psychosocial rehabilitation, patient's medical adherence, etc. However, hospital spending of EOL could not reflect these costs. Fourth, our study was also subject to many limitations frequently reported in analyses of medical databases, such as selection bias of patients and variability of coding between hospitals. Our approach to risk adjustment relied on administrative data that had well-known limitations in clinical details; in particular, we did not have the data for the severity of mental illnesses or the type and dosage of psychotropic drugs. Finally, our study was observational and cross-sectional. It permitted us to determine associations, and not to draw conclusions of the causality.

Conclusion

Hospitals that spend more at the EOL had lower mortality and rehospitalization rates for patients with schizophrenia, but this relationship was not observed in BPD or MDD patients. MDD patients were generally more anxious and sensitive to mental and physical problems. They might have actively requested more medical exams or treatment, or they might have shifted to treatment in medical centers, i.e., the high-spending hospitals, if they felt worse. So most of these associations could be explained by patients' characteristics more than hospitals' characteristics.

Data Availability Statement

The data underlying this study are from the National Health Insurance Research Database which has been transferred to the Health and Welfare Data Science Center (HWDC). The Taiwan government prohibits release of the NHI dataset to the public domain. Interested researchers can obtain the data through formal application to the HWDC, Department of Statistics, Ministry of Health and Welfare, Taiwan (http://dep.mohw.gov.tw/DOS/np-2497-113.html).

Abbreviations

patients with severe mental illness (SMI), Taiwan National Health Research Institute Database (NHRID), Hospital end-of-life (EOL), Taiwanese Bureau of National Health Insurance (BNHI), congestive heart failure (CHF), diabetes mellitus (DM), hypertension (HTN), bipolar disorder (BPD) , major depressive disorder (MDD), Charlson Comorbidity Index (CCI) scores

Declarations

Funding:

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Competing interests:

The authors declare no competing interests.

Ethics Statement:

This data involves collection of sensitive information, thus any requests for access to this data must first be approved by the Institutional Review Board (IRB) of Kaohsiung Municipal Kai-Syuan Psychiatric Hospital (Ethical code: KSPH 102031).

Availability of data and materials:

The International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) was used for diagnostic coding of the Taiwanese Bureau of National Health Insurance (BNHI). The BNHI released medical service data as an anonymous public database for research called the National Health Research Institute Database (NHRID). The NHRID consists of ambulatory card records, inpatient card records and the registration files of the insured. The completeness and accuracy of NHRID has been confirmed by the Taiwan Department of Health and the BNHI through audit (Bai, Su, & Chen, 2013).

Authors' contributions:

Lin SC: The main writer of this manuscript and participate in research project design and data management.

Shen SP: The data management, and participate in research project design.

Wang HY: The response for this research project, and revise partial manuscript.

Tsai KY: The design and response for this research project, and revise partial manuscript.

Chou FH: The design and response for this research project, data management, and revise manuscript.

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