



RESEARCH ARTICLE

Characteristics and related factors of emergency department visits, readmission, and hospital transfers of inpatients under a DRG-based payment system: A nationwide cohort study

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Data Availability Statement: Regarding the data availability, data were obtained from the National Health Insurance Research Database published by the Ministry of Health and Welfare, Taiwan. Due to legal restrictions imposed by the Taiwan government related to the Personal Information Protection Act, the database cannot be made publicly available. All researchers can apply for using the databases to conduct their studies. Requests for data can be sent as a formal proposal to the Health and Welfare Data Science Center of

Abstract

Objectives

Taiwan has implemented the Diagnosis Related Groups (DRGs) since 2010, and the quality of care under the DRG-Based Payment System is concerned. This study aimed to examine the characteristics, related factors, and time distribution of emergency department (ED) visits, readmission, and hospital transfers of inpatients under the DRG-Based Payment System for each Major Diagnostic Category (MDC).

Methods

We conducted a retrospective cohort study using data from the National Health Insurance Research Database (NHIRD) from 2012 to 2013 in Taiwan. Multilevel logistic regression analysis was used to examine the factors related to ED visits, readmissions, and hospital transfers of patients under the DRG-Based Payment System.

Results

In this study, 103,779 inpatients were under the DRG-Based Payment System. Among these inpatients, 4.66% visited the ED within 14 days after their discharge. The factors associated with the increased risk of ED visits within 14 days included age, lower monthly salary, urbanization of residence area, comorbidity index, MDCs, and hospital ownership ($p < 0.05$). In terms of MDCs, Diseases and Disorders of the Kidney and Urinary Tract (MDC11) conferred the highest risk of ED visits within 14 days (OR = 4.95, 95% CI: 2.69–9.10). Of the inpatients, 6.97% were readmitted within 30 days. The factors associated with the increased risk of readmission included gender, age, lower monthly salary, comorbidity index, MDCs,

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Abbreviations: DRGs, Diagnosis Related Groups; MDC, Major Diagnostic Category; NHI, National Health Insurance; NHIRD, National Health Insurance Research Database; ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification; CCI, Charlson Comorbidity Index; ED, Emergency department; OR, odds ratio; CI, confidence interval; PPS, Prospective payment system; NTD, New Taiwan dollar; IRB, institution review board; SSTI, skin and soft tissue infection.

and hospital ownership ($p < 0.05$). In terms of MDCs, the inpatients with Pregnancy, Child-birth and the Puerperium (MDC14) had the highest risk of readmission within 30 days (OR = 20.43, 95% CI: 13.32–31.34). Among the inpatients readmitted within 30 days, 75.05% of them were readmitted within 14 days. Only 0.16% of the inpatients were transferred to other hospitals.

Conclusion

The study shows a significant correlation between Major Diagnostic Categories in surgery and ED visits, readmission, and hospital transfers. The results suggested that the main reasons for the high risk may need further investigation for MDCs in ED visits, readmissions, and hospital transfers.

1. Introduction

Many countries have successfully implemented Prospective Payment Systems (PPSs) to increase hospitals' efficiency in treating patients. The Diagnosis Related Groups (DRGs) belong to the PPS. In 1983, this system was officially adopted by the US Medicare [1], with many countries following suit [2].

After implementing DRG-based payment systems in the USA, Germany, Korea, and other countries, the average length of hospitalization was significantly reduced [3–6]. Some studies have analyzed this based on specific or common surgical cases, and the results showed that healthcare quality either improved or showed no significant change after system implementation [7–9]. In addition to the common measure of "length of hospitalization," healthcare quality indicators also include the post-discharge readmission rate (such as ED visits and readmission rate), hospital transfer rate, and intensity of care (i.e., the number of orders during one's hospitalization) [7–9]. Although DRG-based payment systems are widely used, they still have some hidden problems. Studies suggest that hospitals may discharge patients earlier due to cost considerations, which could adversely impact healthcare quality [10]. Many studies showed that there is a reduction in healthcare quality, such as earlier hospital discharge, increased readmission, and unsatisfactory patient care [11–15].

Since 2010, Taiwan has implemented the National Health Insurance Taiwanese Diagnosis Related Groups (Tw-DRG) payment system in stages. In this system, there is a fixed hospitalization payment by the National Health Insurance to the medical institutions that are estimated based on the medical costs of previous identical or similar diseases. From January 2010 to June 2014, the first stage of this system was implemented in 164 Major Diagnostic Categories (MDCs). After the system was implemented, the average LOS decreased. There was an increase in 3-day ED visits and a 14-day readmission rate initially in 2010, which, however, declined in 2011 when the NHI administration took charge [16]. Whether the decline in ED visits and readmission rates is a result of strict control procedures described in the literature [11, 12], which may in turn increase readmission rates, or are due to delayed ED visits and readmissions to avoid indicator monitoring intentionally. Previous studies showed that possible factors for readmission and ED visits of patients include gender, age, socioeconomic status, and comorbidity [17–21]. Some DRG-related patients might be transferred to other hospitals due to cost-saving issues or other reasons. Previous studies showed that hospital transfer of critically ill patients might put patients at high risk [22], and factors that cause hospital transfers include gender, age, and comorbidity [23–25].

Many studies demonstrate that healthcare behavior is also a research emphasis in addition to healthcare quality, and they unanimously state that system implementation will cause changes in healthcare behavior [7, 26–28]. These changes may also include adverse effects. Previously, studies found that DRG-based payment systems induce morally questionable practices such as upcoding and cream-skimming, which causes an increase in the number of readmitted patients and patient selection [5, 29–33]. Concerning the effects of DRG-based payment systems on medical costs in various countries, most studies showed that total medical cost increased after system implementation [9, 34–36].

Most existing studies on DRG-based payment systems have analyzed specific diseases or their scope [9, 14]. Few studies examined the ED visits and readmission of patients in a variety of MDCs under DRG-based payment systems. Therefore, this study examines 12 MDCs in the DRG-based payment system in Taiwan from 2012 and 2013 to comprehensively analyze the distribution status and relevant factors of ED visits and readmissions of patients and the characteristics of inpatients who transferred to other hospitals and the relevant factors.

2. Methods

2.1. Data source and participants

This study is a retrospective cohort study. The data were obtained from the National Health Insurance Research Database (NHIRD) released by the National Health Research Institutes from 2012 to 2013. Inpatients in the DRG-based payment system from 1 January 2012 to 30 November 2013 were the subjects of this study, and 12 MDCs were included: MDC2, MDC3, MDC5, MDC6, MDC7, MDC8, MDC9, MDC10, MDC11, MDC12, MDC13, and MDC14. These 12 MDCs concern surgical conditions. In order to avoid subject dependence, only the first DRG hospitalization of every subject during the range of the study period was included, and data from the second hospitalization onwards were not included. It means that every sample has one set of hospitalization data within the range of the study period.

This study is mainly organized into three sections: ED visits, readmissions, and hospital transfers of inpatients under the DRG-based payment system. The first section of the analysis examined whether inpatients visited the ED within 14 days after discharge and examined the time distribution of ED visits. The second section of the analysis examined readmitted patients using 30 days after discharge as the observation period. Patients were divided into two populations depending on whether they were readmitted or not. Besides, the time distribution of readmissions of patients who were readmitted within 30 days after discharge was examined. The third section of the analysis examined hospital transfer inpatients, and the parental population was divided for comparison based on whether hospital transfers occurred.

As our study examined 30-day readmission, subjects from 1 January 2012 to 30 November 2013 were included, and subjects who were discharged after 1 December 2013 (including on that day) were excluded ($n = 4,328$). Our study also excluded patients who sought consultation at EDs in clinics ($n = 5$) and patients with missing data ($n = 359$).

2.2. Description of variables

In this study, the dependent variables included (1) Whether the patient visited the ED within 14 days after discharge; (2) Whether patients were readmitted within 30 days after discharge; (3) Whether hospitalized patients were transferred to other hospitals for treatment.

Independent variables included (1) patient demographic characteristics (i.e., gender, age), economic factor (i.e., monthly salary), health status (i.e., Charlson Comorbidity Index, CCI), disease diagnosis status (i.e., Major Diagnostic Categories, MDCs), emergency department triage scale, route of hospitalization (i.e., whether through the emergency department or not),

and whether diagnoses were same as previous ones; (2) inpatient hospital characteristics (i.e., hospital accreditation level, hospital ownership, number of hospital beds); and (3) environmental factors (i.e., degree of urbanization of residence area, degree of urbanization of the hospital's location).

The particular variables are described as follows: (1) The economic status of patients was measured using a monthly salary. In this study, monthly salary was classified into the ranges of $\leq 17,880$ NTD (New Taiwan Dollar), 17,881–22,800 NTD, 22,801–28,800 NTD, 28,801–36,300 NTD, 36,301–45,800 NTD, 45,801–57,800 NTD, and $\geq 57,801$ NTD. (2) For environmental factors, the level of urbanization of the place of residence was used. It was divided into Levels 1 to 7, with Level 1, the highest, and Level 7 the lowest [37]. (3) The severity of comorbidities in patients was measured using Deyo's Charlson Comorbidity Index (CCI) modified and developed by Deyo et al. [38]. The primary diagnosis code for diseases was converted to weighted scores that were totaled to obtain the Deyo's CCI score. In this study, the scores were divided into ranges of 0, 1, 2, and ≥ 3 . (4) MDCs were the 12 categories in the DRG-based payment system from 2012 to 2013, which were: MDC2: Diseases and Disorders of the Eye, MDC3: Diseases and Disorders of the Ear, Nose, Mouth, and Throat, MDC5: Diseases and Disorders of the Circulatory System, MDC6: Diseases and Disorders of the Digestive System, MDC7: Diseases and Disorders of the Hepatobiliary System and Pancreas, MDC8: Diseases and Disorders of the Musculoskeletal System and Connective Tissue, MDC9: Diseases and Disorders of the Skin, Subcutaneous Tissue, and Breast, MDC10: Endocrine, Nutritional, and Metabolic Diseases and Disorders, MDC11: Diseases and Disorders of the Kidney and Urinary Tract, MDC12: Diseases and Disorders of the Male Reproductive System, MDC13: Diseases and Disorders of the Female Reproductive System, and MDC14: Pregnancy, Childbirth, and the Puerperium. Whether patients had the same diagnosis was determined based on the International Disease Classification Code (ICD-9-CM) diagnosis. The primary and secondary diagnoses during ED visits or readmissions were compared to see if they were identical to the primary diagnosis from the previous hospitalization stay. The emergency treatment triage scale used was the five-level Taiwan Triage and Acuity Scale released by the Ministry of Health and Welfare, with Level 1 being resuscitation, Level 2 emergency, Level 3 urgent, Level 4 less urgent, and Level 5 non-urgent [39]. (5) For inpatient hospital characteristics, hospitals were divided by accreditation level into medical centers, regional hospitals, and district hospitals. For hospital ownership, hospitals were divided into public and non-public hospitals. Hospital bed scores were divided into groups of ≤ 300 beds, 301–600 beds, 601–1000 beds, 1001–1500 beds, and ≥ 1501 beds.

2.3. Statistical analysis

Descriptive statistics were used to analyze ED visits within 14 days after discharge, the time distribution of 30-day readmissions, and whether patients were transferred to another hospital during hospitalization under the DRG-based payment system from 2012 to 2013. Independent variables were defined as described above in the description of variables.

Multilevel logistic regression was used to test the correlation between “ED visits within 14 days after discharge,” “readmission within 30 days,” and “hospital transfers” of inpatients under the DRG-based payment system with variables, including (1) individual-level such as patient characteristics, economic status, health status, disease diagnosis status, and route of hospitalization; (2) hospital-level such as hospital characteristics; (3) regional level such as environmental factors. SAS version 9.4 (SAS Institute Inc., Cary, NC, USA) statistics software was used for data processing and statistical analysis. A difference of $p < 0.05$ was considered to be statistically significant. In this study, all personal identification information was deleted,

and personal privacy was protected during the use of these data. The research ethics committee approved this study at China Medical University and Hospital (IRB Number: CMU-REC-101-012).

3. Results

From 2012 to 2013, a total of 103,779 inpatients under the DRG-based payment system were included as study subjects (Table 1), with females accounting for most of the patients (66.72%). Most patients were from the age group of 19–44 years (49.39%) and had a CCI score of 0 (68.9%). In terms of MDCs, most patients (30.02%) had a diagnosis of Pregnancy, Child-birth, and the Puerperium (MDC14), followed by patients (25.4%) with Diseases and Disorders of the Musculoskeletal System and Connective Tissue (MDC8). Concerning the hospital accreditation level, most patients were admitted to regional hospitals (43.41%). About hospital ownership, most patients were admitted to non-public hospitals (76.76%).

For ED visits, we can see from Table 2 that 4,831 inpatients had ED visits within 14 days (accounting for 4.66%). Among these ED patients, 8.76% had the same primary and secondary diagnoses as on the previous hospitalization. From the bivariate analysis results in Table 2, we can see that factors, including gender, age, monthly salary, degree of urbanization of residence area, CCI, MDCs, hospital accreditation level, and hospital ownership, showed a significant correlation with ED visits within 14 days after discharge ($p < 0.05$).

Table 1. Baseline DRGs patient characteristics.

Variable	N	%	Variable	N	%
Total	103,779	100.00	MDC3	4,294	4.14
gender			MDC5	8,942	8.62
female	69,240	66.72	MDC6	15,285	14.73
male	34,539	33.28	MDC7	3,672	3.54
age (year)			MDC8	26,365	25.40
≤18	2,456	2.37	MDC9	395	0.38
19–44	51,261	49.39	MDC11	129	0.12
45–64	26,531	25.56	MDC12	1,500	1.45
≥65	23,531	22.67	MDC13	9,019	8.69
monthly salary (NTD)			MDC14	31,158	30.02
≤17,280	1,468	1.41	hospital accreditation level		
17,281–22,800	41,238	39.74	medical center	35,568	34.27
22,801–28,800	20,467	19.72	regional hospital	45,055	43.41
28,801–36,300	15,681	15.11	district hospital	23,156	22.31
36,301–45,800	11,276	10.87	hospital ownership		
45,801–57,800	6,078	5.86	public hospital	24,119	23.24
≥57,801	7,571	7.30	non-public hospital	79,660	76.76
Charlson Comorbidity Index (CCI)			urbanization of residence area		
0	71,506	68.90	Level 1	29,712	28.63
1	16,289	15.70	Level 2	34,272	33.02
2	8,005	7.71	Level 3	16,382	15.79
≥3	7,979	7.69	Level 4	14,008	13.50
Major Diagnostic Category (MDC)			Level 5	1,881	1.81
MDC10	1,878	1.81	Level 6	3,749	3.61
MDC2	1,142	1.10	Level 7	3,775	3.64

Note: The hospital is the hospital that DRGs patient discharged from.

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Table 2. Bivariate and multilevel regression analysis of DRGs patients' emergency department visits within 14 days after discharge.

Variable	No		Yes		P value	Adjusted OR	95%CI		P value
	N	%	N	%					
Total	98,948	95.34	4,831	4.66					
gender					<0.001				
female (<i>ref.</i>)	66,235	95.66	3,005	4.34		1.00			
male	32,713	94.71	1,826	5.29		1.00	0.93	1.08	0.952
age (year)					<0.001				
≤18 (<i>ref.</i>)	2,369	96.46	87	3.54		1.00			
19–44	49,155	95.89	2,106	4.11		1.15	0.92	1.44	0.228
45–64	25,515	96.17	1,016	3.83		0.98	0.78	1.23	0.871
≥65	21,909	93.11	1,622	6.89		1.42	1.12	1.78	0.003
monthly salary (NTD)					<0.001				
≤17,280(<i>ref.</i>)	1,342	91.42	126	8.58		1.00			
17,281–22,800	39,368	95.47	1,870	4.53		0.51	0.42	0.62	<0.001
22,801–28,800	19,446	95.01	1,021	4.99		0.59	0.48	0.71	<0.001
28,801–36,300	14,894	94.98	787	5.02		0.54	0.44	0.66	<0.001
36,301–45,800	10,836	96.10	440	3.90		0.48	0.39	0.59	<0.001
45,801–57,800	5,824	95.82	254	4.18		0.51	0.40	0.64	<0.001
≥57,801	7,238	95.60	333	4.40		0.53	0.42	0.66	<0.001
Charlson Comorbidity Index (CCI)					<0.001				
0 (<i>ref.</i>)	68,775	96.18	2,731	3.82		1.00			
1	15,469	94.97	820	5.03		1.28	1.17	1.40	<0.001
2	7,511	93.83	494	6.17		1.51	1.35	1.69	<0.001
≥3	7,193	90.15	786	9.85		2.37	2.14	2.62	<0.001
Major Diagnostic Category(MDC)					<0.001				
MDC10 (<i>ref.</i>)	1,843	98.14	35	1.86		1.00			
MDC2	1,103	96.58	39	3.42		1.23	0.77	1.97	0.389
MDC3	4,141	96.44	153	3.56		1.89	1.30	2.75	<0.001
MDC5	8,350	93.38	592	6.62		2.49	1.75	3.54	<0.001
MDC6	14,530	95.06	755	4.94		2.45	1.73	3.47	<0.001
MDC7	3,525	96.00	147	4.00		1.83	1.25	2.66	0.002
MDC8	25,063	95.06	1,302	4.94		2.11	1.50	2.98	<0.001
MDC9	387	97.97	8	2.03		0.95	0.44	2.08	0.901
MDC11	111	86.05	18	13.95		4.95	2.69	9.10	<0.001
MDC12	1,332	88.80	168	11.20		4.23	2.88	6.20	<0.001
MDC13	8,758	97.11	261	2.89		1.65	1.15	2.37	0.006
MDC14	29,805	95.66	1,353	4.34		2.66	1.88	3.77	<0.001
hospital accreditation level					<0.001				
medical center (<i>ref.</i>)	33,886	95.27	1,682	4.73		1.00			
regional hospital	42,799	94.99	2,256	5.01		1.07	0.45	2.51	0.503
district hospital	22,263	96.14	893	3.86		0.87	0.35	2.19	0.312
hospital ownership					<0.001				
public hospital (<i>ref.</i>)	22,813	94.59	1,306	5.41		1.00			
non-public hospital	76,135	95.57	3,525	4.43		0.78	0.70	0.87	<0.001
urbanization of residence area					<0.001				
Level 1 (<i>ref.</i>)	28,402	95.59	1,310	4.41		1.00			
Level 2	32,698	95.41	1,574	4.59		1.03	0.95	1.11	0.484
Level 3	15,673	95.67	709	4.33		0.98	0.89	1.08	0.711

(Continued)

Table 2. (Continued)

Variable	No		Yes		P value	Adjusted OR	95%CI		P value
	N	%	N	%					
Level 4	13,267	94.71	741	5.29		1.13	1.02	1.26	0.015
Level 5	1,797	95.53	84	4.47		0.85	0.67	1.08	0.185
Level 6	3,539	94.40	210	5.60		1.13	0.97	1.33	0.122
Level 7	3,572	94.62	203	5.38		1.11	0.95	1.31	0.189
same diagnosis									
No	-	-	4,408	91.24		-	-	-	-
Yes	-	-	423	8.76		-	-	-	-
emergency triage and acuity scale									
Level 1	-	-	139	2.88		-	-	-	-
Level 2	-	-	832	17.22		-	-	-	-
Level 3	-	-	2,722	56.34		-	-	-	-
Level 4	-	-	795	16.46		-	-	-	-
Level 5	-	-	115	2.38		-	-	-	-
unknown	-	-	228	4.72		-	-	-	-

Note: The hospital is the hospital that DRGs patient discharged from.

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Multilevel logistic regression was then used to examine factors associated with ED visits within 14 days (Table 2) and identified age, monthly salary, CCI, MDC, hospital ownership, and urbanization of residence area correlated with visits ($p < 0.05$). In terms of age, patients ≤ 18 years as the reference group, the number of ED visits within 14 days was higher in patients aged ≥ 65 years old than in the reference group (OR = 1.42, 95% CI: 1.12–1.78). Patients with a monthly salary of $\leq 17,280$ NTD as the reference group and the risk of ED visits within 14 days were lower in patients with higher monthly salaries than the reference group ($p < 0.05$). Patients from generally rural areas (Level 4) have a higher risk of ED visits within 14 days (OR = 1.13, 95% CI: 1.02–1.26). In terms of severity of comorbidities, the results showed that the higher the CCI score, the higher the risk of ED visits within 14 days ($p < 0.05$).

In terms of MDCs, patients with Endocrine, Nutritional, and Metabolic Diseases and Disorders (MDC10) as the reference group, patients with Diseases and Disorders of the Kidney and Urinary Tract (MDC11) had the highest risk of ED visits within 14 days (OR = 4.95, 95% CI: 2.69–9.10), followed by patients with Diseases and Disorders of the Male Reproductive System (MDC12) (OR = 4.23, 95% CI: 2.88–6.20). The risk of ED visits within 14 days was significantly lower for patients from non-public hospitals than for those from public hospitals (OR = 0.78, 95% CI: 0.70–0.87).

We further examined the time distribution status of ED visits within 14 days after discharge and calculated the interval between discharge and ED visits by subtracting the ED visit date from the discharge date. Fig 1 shows that the proportion of patients with ED visits within one day after discharge was the highest (18.82%), which gradually decreased with the number of days. Within three days of discharge, the proportion of patients with ED visits accounted for 37.57%. Among patients visiting ED, the proportions of patients with ED visits on Day 4 (8.16%) and Day 5 (8.28%) were similar to that on Day 3 (8.92%).

Section 2 of the analysis examines whether patients were readmitted to the hospitals within 30 days of discharge. From Table 3, we can see that 7,234 patients were readmitted within 30 days (accounting for 6.97%). Among these patients, 9.28% of patients had the same primary and secondary diagnoses as the previous hospitalization. From the bivariate analysis results in

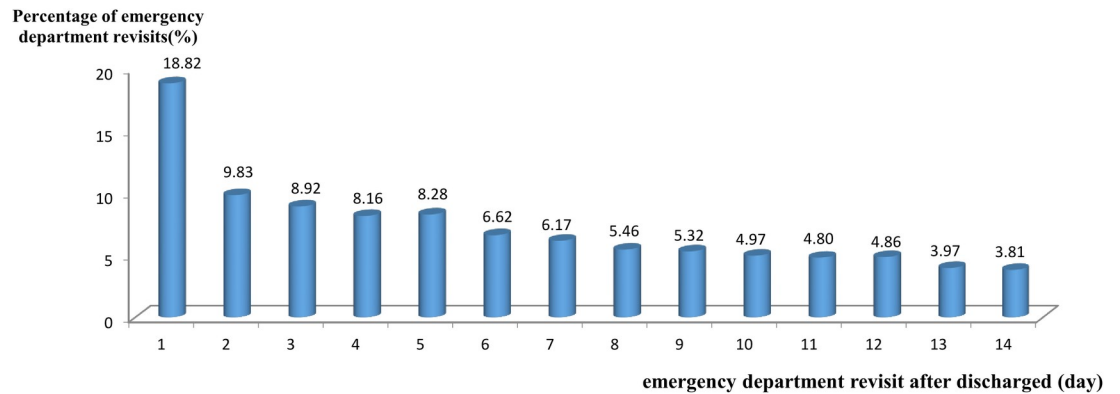


Fig 1. The time distribution of emergency department visits within 14 days after discharge.

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Table 3, we can see that gender, age, monthly salary, CCI, MDCs, hospital accreditation level, and hospital ownership show a significant correlation with readmission within 30 days of discharge ($p < 0.05$).

We employed multilevel logistic regression to examine factors associated with readmission within 30 days (Table 3). The results show that gender, age, monthly salary, CCI, MDCs, and hospital ownership showed significant correlations with readmission within 30 days of discharge ($p < 0.05$). In terms of gender, the risk of male patients being readmitted within 30 days of discharge was significantly higher than in female patients (OR = 1.28, 95% CI: 1.18–1.39). Patients ≤ 18 years used as the reference group. The patients who were older than the reference group had a significantly higher risk of readmission within 30 days ($p < 0.05$), and the risk of readmission within 30 days increased with age. In terms of monthly salary, patients with a monthly salary of $\leq 17,280$ NTD taken as the reference group, the risk of readmission within 30 days is significantly lower in patients with higher monthly salaries than the reference group ($p < 0.05$). In terms of severity of comorbidities, results showed that the higher the CCI score, the higher the risk of readmission within 30 days ($p < 0.05$). In terms of MDCs, patients with Endocrine, Nutritional, and Metabolic Diseases and Disorders (MDC10) used as the reference group, as they had the lowest proportion of readmission within 30 days, results showed that patients with Pregnancy, Childbirth, and the Puerperium (MDC14) had the highest risk of readmission within 30 days (OR = 20.43, 95%CI: 13.32–31.34), followed by patients with Diseases and Disorders of the Skin, Subcutaneous Tissue, and Breast (MDC9) (OR = 9.53, 95% CI: 5.62–16.13). Public hospitals taken as the reference group, patients from non-public hospitals had a significantly lower risk of readmission within 30 days (OR = 0.80, 95%CI:0.67–0.96).

We further examined the time distribution of readmission within 30 days of discharge and calculated the interval between discharge and readmission by subtracting the readmission date from the discharge date. From Fig 2, we can see that the proportion of patients with readmission within one day after discharge was the highest (26.38%), which gradually decreased with the number of days. Within 14 days of discharge, the proportion of patients with readmission accounted for 75.05%.

Section 3 of the analysis examined patients who underwent hospital transfers. From Table 4, we can see that out of 103,779 inpatients, only 169 inpatients transferred hospitals (accounting for 0.16%). From the bivariate analysis in Table 4, we can see that gender, age, urbanization of residence area, urbanization of the hospital's location, CCI, MDCs, hospital accreditation level, number of hospital beds, and route of hospitalization were significantly correlated with whether patients underwent hospital transfers ($p < 0.05$).

Table 3. Bivariate and multilevel regression analysis of DRGs patients' readmissions within 30 days after discharge.

Variable	Total		No		Yes		P value	Adjusted OR	95%CI		P value
	N	%	N	%	N	%					
Total	103,779	100.00	96,545	93.03	7,234	6.97					
gender							<0.001				
female (<i>ref.</i>)	69,240	66.72	63,832	92.19	5,408	7.81		1.00			
male	34,539	33.28	32,713	94.71	1,826	5.29		1.28	1.18	1.39	<0.001
age (year)							<0.001				
≤18 (<i>ref.</i>)	2,456	2.37	2,397	97.60	59	2.40		1.00			
19–44	51,261	49.39	46,888	91.47	4,373	8.53		1.35	1.02	1.77	0.033
45–64	26,531	25.56	25,512	96.16	1,019	3.84		1.69	1.29	2.23	<0.001
≥65	23,531	22.67	21,748	92.42	1,783	7.58		2.54	1.93	3.35	<0.001
monthly salary (NTD)							<0.001				
≤17,280 (<i>ref.</i>)	1,468	1.41	1,301	88.62	167	11.38		1.00			
17,281–22,800	41,238	39.74	38,425	93.18	2,813	6.82		0.48	0.40	0.57	<0.001
22,801–28,800	20,467	19.72	19,109	93.36	1,358	6.64		0.48	0.40	0.58	<0.001
28,801–36,300	15,681	15.11	14,523	92.62	1,158	7.38		0.50	0.42	0.60	<0.001
36,301–45,800	11,276	10.87	10,508	93.19	768	6.81		0.48	0.40	0.58	<0.001
45,801–57,800	6,078	5.86	5,605	92.22	473	7.78		0.45	0.37	0.54	<0.001
≥57,801	7,571	7.30	7,074	93.44	497	6.56		0.48	0.39	0.58	<0.001
Charlson Comorbidity Index (CCI)							<0.001				
0 (<i>ref.</i>)	71,506	68.90	66,726	93.32	4,780	6.68		1.00			
1	16,289	15.70	15,342	94.19	947	5.81		1.19	1.10	1.29	<0.001
2	8,005	7.71	7,441	92.95	564	7.05		1.58	1.42	1.75	<0.001
≥3	7,979	7.69	7,036	88.18	943	11.82		2.62	2.38	2.89	<0.001
Major Diagnostic Category (MDC)							<0.001				
MDC10 (<i>ref.</i>)	1,878	1.81	1,855	98.78	23	1.22		1.00			
MDC2	1,142	1.10	1,055	92.38	87	7.62		3.33	2.06	5.37	<0.001
MDC3	4,294	4.14	4,231	98.53	63	1.47		1.13	0.69	1.84	0.628
MDC5	8,942	8.62	8,093	90.51	849	9.49		4.45	2.91	6.82	<0.001
MDC6	15,285	14.73	14,839	97.08	446	2.92		1.87	1.22	2.87	0.004
MDC7	3,672	3.54	3,555	96.81	117	3.19		1.98	1.26	3.13	0.003
MDC8	26,365	25.40	24,984	94.76	1,381	5.24		3.05	2.00	4.66	<0.001
MDC9	395	0.38	351	88.86	44	11.14		9.53	5.62	16.13	<0.001
MDC11	129	0.12	116	89.92	13	10.08		3.98	1.93	8.20	<0.001
MDC12	1,500	1.45	1,397	93.13	103	6.87		2.52	1.58	4.04	<0.001
MDC13	9,019	8.69	8,875	98.40	144	1.60		1.64	1.04	2.57	0.032
MDC14	31,158	30.02	27,194	87.28	3,964	12.72		20.43	13.32	31.34	<0.001
hospital accreditation level							<0.001				
medical center (<i>ref.</i>)	35,568	34.27	33,425	93.97	2,143	6.03		1.00			
regional hospital	45,055	43.41	41,379	91.84	3,676	8.16		1.25	0.23	6.69	0.339
district hospital	23,156	22.31	21,741	93.89	1,415	6.11		0.87	0.17	4.59	0.485
hospital ownership							0.036				
public hospital (<i>ref.</i>)	24,119	23.24	22,511	93.33	1,608	6.67		1.00			
non-public hospital	79,660	76.76	74,034	92.94	5,626	7.06		0.80	0.67	0.96	0.019
urbanization of residence area							0.147				
Level 1 (<i>ref.</i>)	29,712	28.63	27,666	93.11	2,046	6.89		1.00			
Level 2	34,272	33.02	31,887	93.04	2,385	6.96		0.99	0.93	1.06	0.855
Level 3	16,382	15.79	15,292	93.35	1,090	6.65		1.02	0.94	1.11	0.683

(Continued)

Table 3. (Continued)

Variable	Total		No		Yes		P value	Adjusted OR	95%CI		P value
	N	%	N	%	N	%					
Level 4	14,008	13.50	13,009	92.87	999	7.13		1.01	0.92	1.11	0.828
Level 5	1,881	1.81	1,745	92.77	136	7.23		1.15	0.94	1.39	0.168
Level 6	3,749	3.61	3,460	92.29	289	7.71		1.14	0.99	1.32	0.073
Level 7	3,775	3.64	3,486	92.34	289	7.66		1.11	0.96	1.28	0.172
readmission with same diagnosis											
No					6,563	90.72		-	-	-	-
Yes					671	9.28		-	-	-	-

Note: The hospital was the hospital that DRGs patients discharged from.

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We employed multilevel logistic regression to examine factors associated with hospital transfers (Table 4). Results showed that gender, CCI, MDCs, number of hospital beds, and hospitalization route showed significant correlations with hospital transfers ($p < 0.05$). Regarding gender, the risk of hospital transfer in male patients was significantly higher than in female patients (OR = 1.74, 95%CI: 1.13–2.70). In terms of severity of comorbidities, patients with a CCI score of 2 points (OR = 2.88, 95%CI: 1.68–4.96) or ≥ 3 points (OR = 2.45, 95%CI: 1.40–4.30) had the highest risk of hospital transfers. Concerning MDCs, disease categories without hospital transfers (MDC 2, 3, 9, 10, 11, and 12) were excluded. Patients with Diseases and Disorders of the Circulatory System (MDC5) had the highest risk of hospital transfer (OR = 9.51, 95% CI: 2.09–43.19), followed by patients with Pregnancy, Childbirth, and the Puerperium (MDC14) (OR = 5.61, 95%CI: 1.32–23.83). In terms of the number of hospital beds, patients from hospitals with ≥ 601 beds had a significantly lower risk of hospital transfer ($p < 0.05$), and overall patients from hospitals with ≥ 1501 beds had the lowest risk of hospital transfer (OR = 0.09, 95%CI: 0.01–0.58). In terms of route of hospitalization, patients who were admitted through the ED had a significantly higher risk of hospital transfer (OR = 2.36, 95% CI: 1.71–3.27).

4. Discussion

This study examined the patient characteristics of ED visits within 14 days and the relevant factors for such patients under the DRG-based payment system. Concerning patient characteristics, the results in Table 2 show that patients ≥ 65 years old had the highest risk of ED visits

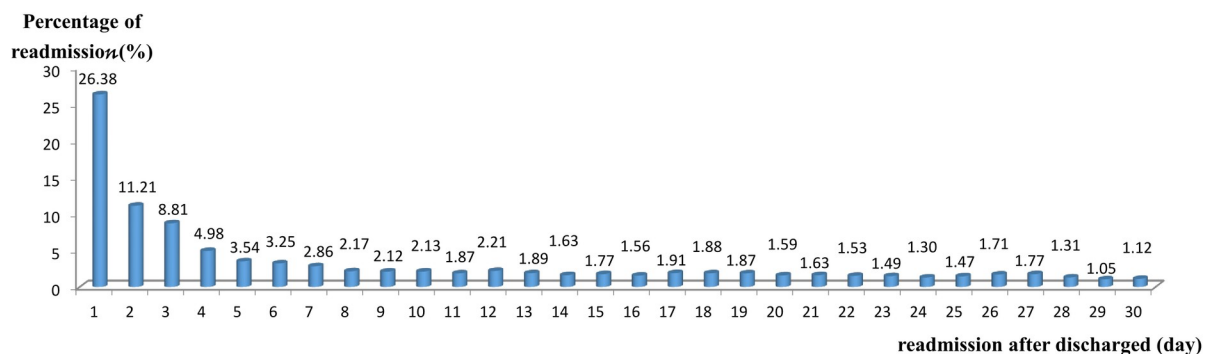


Fig 2. The time distribution of readmission within 30 days after discharge.

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Table 4. Bivariate and multilevel regression analysis of DRGs patients' hospital transfer.

Variable	Total		No		Yes		P value	Adjusted OR	95%CI		P value
	N	%	N	%	N	%					
Total	103,779	100.00	103,610	99.84	169	0.16					
gender							0.030				
female (<i>ref.</i>)	69,240	66.72	69,141	99.86	99	0.14		1.00			
male	34,539	33.28	34,469	99.80	70	0.20		1.74	1.13	2.70	0.013
age (year)							0.011				
≤18 (<i>ref.</i>)	2,456	2.37	2,455	99.96	1	0.04		1.00			
19–44	51,261	49.39	51,184	99.85	77	0.15		2.37	0.31	17.91	0.402
45–64	26,531	25.56	26,495	99.86	36	0.14		2.23	0.30	16.81	0.435
≥65	23,531	22.67	23,476	99.77	55	0.23		2.55	0.34	19.24	0.365
monthly salary (NTD)							0.818				
≤17,280 (<i>ref.</i>)	1,468	1.41	1,466	99.86	2	0.14		1.00			
17,281–22,800	41,238	39.74	41,173	99.84	65	0.16		1.20	0.29	4.98	0.801
22,801–28,800	20,467	19.72	20,429	99.81	38	0.19		1.67	0.40	7.04	0.482
28,801–36,300	15,681	15.11	15,653	99.82	28	0.18		1.44	0.34	6.14	0.626
36,301–45,800	11,276	10.87	11,256	99.82	20	0.18		1.84	0.42	8.03	0.416
45,801–57,800	6,078	5.86	6,071	99.88	7	0.12		1.17	0.24	5.75	0.848
≥57,801	7,571	7.30	7,562	99.88	9	0.12		1.41	0.30	6.66	0.664
Charlson Comorbidity Index (CCI)							<0.001				
0 (<i>ref.</i>)	71,506	68.90	71,420	99.88	86	0.12		1.00			
1	16,289	15.70	16,261	99.83	28	0.17		1.55	0.95	2.51	0.077
2	8,005	7.71	7,979	99.68	26	0.32		2.88	1.68	4.96	<0.001
≥3	7,979	7.69	7,950	99.64	29	0.36		2.45	1.40	4.30	0.002
Major Diagnostic Category (MDC)							<0.001				
MDC13 (<i>ref.</i>)	9,019	8.69	9,017	99.98	2	0.02		1.00			
MDC2	1,142	1.10	1,141	99.91	1	0.09		-	-	-	-
MDC3	4,294	4.14	4,294	100.00	0	0.00		-	-	-	-
MDC5	8,942	8.62	8,893	99.45	49	0.55		9.51	2.09	43.19	0.004
MDC6	15,285	14.73	15,279	99.96	6	0.04		0.60	0.11	3.13	0.540
MDC7	3,672	3.54	3,669	99.92	3	0.08		1.48	0.24	9.26	0.676
MDC8	26,365	25.40	26,321	99.83	44	0.17		1.95	0.44	8.66	0.377
MDC9	395	0.38	395	100.00	0	0.00		-	-	-	-
MDC10	1,878	1.81	1,878	100.00	0	0.00		-	-	-	-
MDC11	129	0.12	129	100.00	0	0.00		-	-	-	-
MDC12	1,500	1.45	1,499	99.93	1	0.07		-	-	-	-
MDC14	31,158	30.02	31,095	99.80	63	0.20		5.61	1.32	23.83	0.020
whether through the ED or not							<0.001				
No (<i>ref.</i>)	77,690	74.86	77,594	99.88	96	0.12		1.00			
Yes	26,089	25.14	26,016	99.72	73	0.28		2.42	1.73	3.39	<0.001
hospital accreditation level							<0.001				
medical center (<i>ref.</i>)	35,496	34.20	35,478	99.95	18	0.05		1.00			
regional hospital	45,089	43.45	44,993	99.79	96	0.21		1.94	0.01	543.05	0.375
district hospital	23,194	22.35	23,139	99.76	55	0.24		1.13	0.00	3342.59	0.874
hospital ownership							0.892				
public hospital (<i>ref.</i>)	24,099	23.22	24,061	99.84	38	0.16		1.00			
non-public hospital	79,680	76.78	79,549	99.84	131	0.16		0.86	0.52	1.42	0.547
number of hospital beds							<0.001				

(Continued)

Table 4. (Continued)

Variable	Total		No		Yes		P value	Adjusted OR	95%CI		P value
	N	%	N	%	N	%					
≤300 beds (<i>ref.</i>)	18,692	18.01	18,645	99.75	47	0.25		1.00			
301–600 beds	17,171	16.55	17,118	99.69	53	0.31		0.51	0.17	1.47	0.174
601–1,000 beds	23,081	22.24	23,040	99.82	41	0.18		0.25	0.07	0.88	0.035
1,001–1,500 beds	23,553	22.70	23,533	99.92	20	0.08		0.15	0.04	0.60	0.014
≥1,501 beds	21,282	20.51	21,274	99.96	8	0.04		0.09	0.01	0.58	0.018
urbanization of residence area							<0.001				
Level 1 (<i>ref.</i>)	29,712	28.63	29,683	99.90	29	0.10		1.00			
Level 2	34,272	33.02	34,204	99.80	68	0.20		1.44	0.90	2.30	0.123
Level 3	16,382	15.79	16,365	99.90	17	0.10		0.83	0.44	1.55	0.556
Level 4	14,008	13.50	13,972	99.74	36	0.26		1.64	0.94	2.85	0.080
Level 5	1,881	1.81	1,876	99.73	5	0.27		1.94	0.70	5.33	0.200
Level 6	3,749	3.61	3,743	99.84	6	0.16		1.15	0.45	2.93	0.771
Level 7	3,775	3.64	3,767	99.79	8	0.21		1.30	0.56	3.03	0.544
urbanization of hospital's location							<0.001				
Level 1 (<i>ref.</i>)	33,833	32.60	33,809	99.93	24	0.07		1.00			
Level 2	49,153	47.36	49,054	99.80	99	0.20		1.77	0.98	3.20	0.059
Level 3	8,154	7.86	8,141	99.84	13	0.16		1.48	0.63	3.46	0.363
Level 4	11,474	11.06	11,442	99.72	32	0.28		1.71	0.83	3.54	0.146
Level 5–7	1,165	1.12	1,164	99.91	1	0.09		0.50	0.06	4.22	0.519

Note: The hospital was the hospital that DRGs patient discharged from. Logistic regression model did not include MDC2, MDC3, MDC9, MDC10, MDC11, and MDC12 patients.

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within 14 days. It may be because elderly patients are prone to careless falls [40], poor health status, or chronic diseases, which increase the rate of ED visits. Our study showed that patients with a higher monthly salary had a lower risk of ED visits within 14 days. A previous US study examined patients who underwent septorhinoplasty [20]. The results showed that patients with lower socioeconomic status had a higher risk of ED visits within 30 days [20], which is similar to the results of this study. Turning to the severity of comorbidities, the results of this study showed that the risk of ED visits within 14 days increased as the CCI score of patients increased, of whom patients with CCI ≥ 3 points had the highest risk of ED visits within 14 days. It is consistent with the results of a previous US study that examined the risk of ED visits within three days, seven days, 30 days, and one year in patients aged ≥ 65 . The results showed that the higher the CCI score of the patient, the higher the risk of ED visits [40].

About disease diagnosis categories, the results of this study showed that patients with Diseases and Disorders of the Kidney and Urinary Tract (MDC11) had the highest risk of ED visits within 14 days, followed by patients with Diseases and Disorders of the Male Reproductive System (MDC12). A previous study in Taiwan examined patients who had ED visits within three days and showed that patients with diseases of the digestive system accounted for most patients with ED visits [41], which is not consistent with the results of this study. This discrepancy in reporting could be because Diseases and Disorders of the Digestive System (MDC6) in our study included only surgical patients. In contrast, the study subjects in that paper included internal medicine and surgical patients, resulting in differences in the proportion of patients in disease categories. The results of this study show that among patients who had ED visits within 14 days, most patients had a triage grade of 3 (accounting for 56.34%), while the proportion of

patients with triage grades 4 and 5 (18.84%) was similar to that of patients with grades 1 and 2 (20.1%). This result is similar to that of a Canadian study that found that patients with ED visits are mostly less urgent patients and not urgent ones [42].

With regard to the risk of readmission within 30 days of discharge, the results of this study show that male patients had a significantly higher risk than female patients. It is similar to the findings of the previous study in the US of patients with inflammatory bowel disease that examined the characteristics of patients who were readmitted within 30 days [43]. It showed that the risk of readmission within 30 days was higher in males than in female patients [43]. With regard to age, the results of this study showed that patients aged ≥ 65 years old had the highest risk of readmission within 30 days. A previous US study examined the revisit rate (including readmission rate for outpatient procedures, readmission rate, or ED revisit) in patients who underwent septorhinoplasty [20]. Results showed that patients aged ≥ 65 years old had a higher risk of hospital revisit rate [20], which is similar to the results of this study. Concerning monthly salaries, the results of this study showed that patients with higher monthly salaries had a lower risk of readmission within 30 days. A study of patients with inflammatory bowel disease examined the characteristics of patients who were readmitted within 30 days [43] and found that patients with a higher mean income had a lower risk of readmission than patients with a lower mean income is similar to the results of this study.

Concerning the severity of comorbidities, the results of this study showed that patients with CCI ≥ 3 points had the highest risk of readmission within 30 days. A previous US study of patients who underwent colectomy showed that patients with CCI ≥ 2 points had a significantly higher risk of readmission within 30 days [17], which is similar to the results of this study. About disease diagnosis categories, our study found that patients with Pregnancy, Childbirth, and the Puerperium (MDC14) had the highest risk of readmission within 30 days. It may be because pregnancy, childbirth, and puerperium are unstable periods, and patients may be hospitalized for short periods for delivery. Therefore, MDC14 patients have a higher risk of readmission than do patients in other disease diagnosis categories. However, previous studies found that under the DRG-based payment system, the risk of readmission within 30 days in patients who underwent specific obstetric and gynecological surgeries (cesarean section, hysterectomy, etc.) showed a decreasing trend [44]. A previous study in France examined the risk of readmission within 30 days and the trends in patients from different MDCs before and after implementing a DRG-based payment system [45]. They found that as time progressed, ophthalmology gradually became the disease category with the highest risk of readmission within 30 days, while obstetric and gynecological diseases also had a higher risk of readmission within 30 days than other disease categories [45]. Our study also found that patients with Diseases and Disorders of the Skin, Subcutaneous Tissue, and Breast (MDC9) had the second-highest risk of readmission within 30 days. We conducted further analyses and found that a primary reason was that the unilateral total or subtotal mastectomy for carcinoma in situ of the breast without complication and comorbidity had a higher readmission rate. A previous study showed a high rate of incomplete resection in extensive ductal carcinoma in situ (DCIS) of breast cancer, which led to readmission for surgery [46].

In Taiwan, in order to prevent doctors' dividing up DRG-based hospital stays for seeking health insurance reimbursement, the NHI monitored readmissions and would not reimburse for the second admission within 14 days after discharge. From Fig 2, which shows the time distribution of readmission within 30 days of discharge, we can see that patients admitted within 14 days after discharge accounted for 75.03% of all readmissions. A small increase in the number of patients readmitted on day 15 (1.77%) was not significantly different from those who had a readmission on day 14 (1.63%). Thus, from this study, it was not apparent that health-care providers displayed rule avoidance and advantage-taking behaviors as has been

mentioned in previous literature as occurring when DRG-based payment systems were implemented in some countries [29–31].

There has been no study examining the relevant factors for hospital transfer in patients under the DRG-based payment system, and our study can be considered the first paper to do so. The results of this study's analysis show that the risk of hospital transfer in male patients is significantly higher than that of female patients. A previous US study of the relevant factors for hospital transfer in hospitalized patients across the US showed that male patients have a higher risk of hospital transfer than female patients [25], which is similar to the results of this study. It may be because of innate differences in the risk of developing diseases between males and females [47]. We further conducted stratification analyses according to gender among patients who were transferred to other hospitals and found that among this group, male patients were more likely to be older than 45 years (68.14% vs 39.62%) with a higher Charlson comorbidity index as compared to their female counterparts. Besides, 32.68% of male patients were diagnosed with MDC8, which had a higher hospital transfer rate, whereas 21.77% of female patients diagnosed with this category of disease. It is why male patients had a higher risk of hospital transfer than in female patients.

With regard to the severity of comorbidities, the results of this study showed that patients with CCI ≥ 3 points had a higher risk of hospital transfer. A study of patients ≥ 65 years old examined their risk of hospital transfer and showed that patients with higher CCI had a higher risk of hospital transfer [48]. Concerning MDCs, no previous study has compared the correlation between MDCs and the risk of hospital transfer. This study shows that patients with Diseases and Disorders of the Circulatory System (MDC5) had the highest risk of a hospital transfer, followed by patients with Pregnancy, Childbirth, and the Puerperium (MDC14). It is because patients with MDC5 may be emergency patients, and immediate hospital transfer for treatment is required if the hospital is unable to treat the patient immediately, resulting in these patients having a higher risk of hospital transfer than those in other categories. On the other hand, due to emergency, MDC14 patients may be admitted for surgeries to neighboring hospitals that are not those they usually visit for a consultation. Therefore, this may cause patients to transfer to other hospitals after delivery, resulting in a higher risk of hospital transfer.

Moreover, there was no study in the past, examining the correlation between hospital beds and the risk of hospital transfer. Our analysis results showed that patients from hospitals with ≥ 601 beds had a significantly lower risk of a hospital transfer. Patients from hospitals with ≥ 1501 beds had the lowest risk of hospital transfer. This phenomenon is consistent with general reasoning: As the number of beds increases, the hospital has a higher capacity to treat patients. The rate of hospital transfer is relatively lower. Therefore, it can be observed that the risk of hospital transfer decreases as the number of beds increases. About the route of hospitalization, few studies have examined whether the risk of hospital transfer is related to admission through the ED. The results of this study show that patients who were admitted through the ED had a higher risk of hospital transfer. It may be because the hospital where a patient was admitted through the ED for hospitalization and treatment was not the hospital where the patient usually seeks consultation. It results in a higher risk to the patient of hospital transfer during hospitalization.

5. Limitations

Our study was unable to accurately compare the case payment classification method that was implemented before the DRG-based payment system and the classification methods in the DRG-based payment system. Therefore, we were unable to examine the differences before and

after implementing the DRG-based payment system. Besides, we found from our literature review that many factors are associated with readmission or ED visits. However, some data can only be obtained from questionnaire surveys. As our study is an analysis of the NHIRD, we were unable to include all possible factors for a complete examination. Concerning the readmission of study subjects, we were unable to distinguish between planned and unplanned readmissions. Therefore, we were unable to examine patients with unplanned readmissions independently. During the literature review, we found that physician availability is one of the critical factors for ED visits or readmissions by patients. However, as the limited physician data in the NHIRD, we, therefore, did not include physician factors in this study. Finally, since our patients were mainly surgical patients, the study findings cannot be generalized to medical admissions.

6. Conclusions

Our study found that under the DRG-based payment system, MDCs are important correlation factors for ED visits within 14 days, readmission within 30 days, or hospital transfers. This study showed that patients with Diseases and Disorders of the Kidney and Urinary Tract (MDC11) had the highest risk of ED visits within 14 days, followed by patients with Diseases and Disorders of the Male Reproductive System (MDC12). About the risk of readmission within 30 days, patients with Pregnancy, Childbirth, and the Puerperium (MDC14) had the highest risk, followed by patients with Diseases and Disorders of the Skin, Subcutaneous Tissue, and Breast (MDC9). Concerning hospital transfer, patients with Diseases and Disorders of the Circulatory System (MDC5) had the highest risk of hospital transfers, followed by patients with Pregnancy, Childbirth, and the Puerperium (MDC14). We recommend further investigation into the possible reasons for the higher risk of ED visits, readmission, and hospital transfers for patients in the MDCs that have a higher risk of such actions. Finally, we did not find healthcare providers had significant rule avoidance and advantage-taking behaviors, in which hospitals may delay readmission by 1 to 3 days to avoid the 14-day readmission indicator.

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