International Clinical and Medical Case Reports Journal
Research Article (ISSN: 2832-5788)

Hospital Financial Performance Based On Nurse-Patient Ratio and Tw-Drgs in The Post-Pandemic Era: A Comparative Analysis Of Taiwan Before and After COVID-19

Yu-Ting Huang[1], Qiao-Lun Gao[2*]

[1]Assistant Professor, Department of Business Administration, MingDao University

[2]Nurse Practitioner, Emergency Room, Department of Nursing, Kuang Tien General Hospital; EMBA Program, MingDao University

Citation: *Yu-Ting Huang1, Qiao-Lun Gao. Hospital Financial Performance Based On Nurse-Patient Ratio and Tw-Drgs in The Post-Pandemic Era: A Comparative Analysis Of Taiwan Before and After COVID-19. Int Clinc Med Case Rep Jour. 2023;2(1):1-20.* DOI: https://doi.org/10.5281/zenodo.7504918

Received Date: 31 December, 2022**; Accepted Date:** 04 January, 2023**; Published Date:** 06 January, 2023

[*]**Corresponding author:** Qiao-Lun Gao**.** Nurse Practitioner, Emergency Room, Department of Nursing, Kuang Tien General Hospital; EMBA Program, MingDao UniversityNurse Practitioner, Emergency Room, Department of Nursing, Kuang Tien General Hospital; EMBA Program, MingDao University

Copyright: © Qiao-Lun Gao, Open Access 2023. This article, published in Int Clinc Med Case Rep Jour (ICMCRJ) (Attribution 4.0 International), as described by http:// creativecommons.org/licenses/by/4.0/.

ABSTRACT

Background: During the COVID-19 pandemic, and the healthcare system supported by the national health insurance became the key to effective pandemic control. This study compares the number of health insurance points, Tw-DRGs monitoring indicators, nurse–patient ratio, and hospital operating performance of 2 years before and after the start of the COVID-19 pandemic and examines the differences between different hospital levels to understand whether COVID-19 impacts the operating performance of medical institutions.

Methods: Public hospitals in Taiwan were studied before and after the start of the COVID-19 pandemic in 2019 and 2020. The obtained data were further analyzed using the statistical software IBM SPSS Statistics.

Results: The empirical results show that the 3-day readmission rate to the emergency department of the same hospital ($p<.05$) was significantly negatively correlated with the net profit margin. Additionally, the 14-day readmission rate in district hospitals showed a significant positive correlation ($p<.05$) in 2020 while that in medical centers showed a significant negative correlation. The results of the regression analysis indicate that the health insurance points, 14-day readmission rate, 3-day readmission rate to the emergency department of the same hospital, and nurse–patient ratio were important predictors; that is, different hospital levels had different effects on hospital operating performance before and after the start of the COVID-19 pandemic.

Conclusions: Because of the reduction of the number of medical visits, unnecessary medical costs were reduced, and the quality of hospital service, cost control, and medical outcomes were improved. Thus, the financial performance of the hospital improved. Different hospitals have their own corporate model for business strategy and

cost control.

Keywords: COVID-19; Nurse-patient ratio; Taiwan Diagnosis Related Groups; Hospital operating performance

INTRODUCTION

In 2020, the global economy was generally depressed because of the severe challenges resulting from the spread of COVID-19. Through the big data analysis of national health insurance and digital technology, Taiwan effectively curbed the spread of the pandemic. In July 2020, the Bloomberg Economics in the United States ranked Taiwan's anti-epidemic performance as number one. Because of a global shortage of raw materials, the restructuring of global supply chains, and the impact of the pandemic, the annual economic growth rate in Taiwan was 3.11% in 2020, leading the steady growth of Taiwan's economy. The public is still discussing the hard work of healthcare professionals and the increase in health insurance premiums in 2021, as we are still in the midst of the fight against COVID-19. Because the medical expenditures of health insurance have increased year by year since 2016, the financial actuarial report released in 2018 estimated that the rate standard will increase in 2021. Simultaneously, because of the innovation of medical technology, to avoid the medical expenses dragging down the national finance, the Ministry of Health and Welfare increased the premium rate of general insurance to 5.17% and that of the supplementary insurance to 2.11% in 2021. Further, to comply with the principle of transparent and open information of the 2nd Generation National Health Insurance (NHI), the insurance medical service providers that receive more than $200 million for health insurance should submit financial statements in the following year so that the public can better understand the operation of medical institutions and increase the efficiency of the allocation and utilization of medical resources.[1]

With rapid social changes, countries that have implemented the national health insurance system are facing the factors of aging population, rising prices, and advances in medical technology, which has led to a rise in medical expenditures, so they have adopted various methods of control and improvement. Taiwan has implemented a national health insurance system since 1995, the most important aim of which is to benefit numerous disadvantaged groups to achieve the purpose of social solidarity. Several reforms, including the global budget payment system, the 2nd Generation NHI, and Taiwan diagnosis-related groups (Tw-DRGs), are all for the sustainable operation of health insurance. [1,2] Researchers of health insurance financial imbalance have often focused on the aspects of expenditure, which include the aging of population and the phenomenon of fewer children, the advance of medical technology, and the increase in medical services.[3,4] However, research which has documented prevention from the health insurance points to increase were scant, but this benefits the balance of NHI finance with the growth of revenues and brings more fairness to premium copayment.[5] Therefore, the aim of this study attempts to the health insurance points and the hospital financial performance.

Taiwan implemented the global budget payment system in 2005. The National Health Insurance Administration (NHIA) gives subsidies to physicians based on the amount of medical services provided by them, so there is more incentive to pay for volume, which leads to hospitals prescribing unnecessary tests and medication for financial benefits regardless of whether patients need them or not. Therefore, referring to the DRGs system of the United

States,[6,7,8] the Taiwan diagnosis-related groups (Tw-DRGs) payment system was implemented in January 2010 to standardize the medical care process through a clinical pathway management mechanism, allowing patients to be treated according to the recommendations of the clinical pathway after hospitalization until they are discharged from the hospital. This is aimed at maintaining a high standard of care; providing patients with better quality and efficacy of care; and reducing unnecessary tests, medication, and hospital days (National Health Insurance Administration, 2017). Thus, the purpose of Tw-DRGs policy is to improve the efficiency of medical services, as well as care quality and efficacy. The implementation of Tw-DRGs under the global payment system is also a great challenge for hospital operators.[9,10,11]

The system of National Health Insurance in Taiwan is worldwide renowned. In order to curb medical payments, NHI enacted DRG payment system in 2010, which pays medical expenses on a piece basis rather than on a service basis as before. The aim of DRG payment is stimulating hospitals to increase medical efficiency, improve service quality, avoid medical complication and reduce medical costs.[12,13,14] Consequently, it is beneficial to all stakeholders, including NHI, hospitals and patients. However, medical care is a complex practice. Hence, DRG system can lower medical expenses, and give rise to control costs which impact of TW-DRG on the hospital financial performance. After implementing the Tw-DRGs payment system, the medical expenses, mortality rate within 180 days after discharge, and inpatient transfer rate had decreased, but the readmission rate within 180 days after discharge had increased whch the NHI should continue monitoring medical institutions to ensure high-quality medical care, and the measurement of indicators, such as the readmission rate and hospital financial performance, should be more strictly and precisely defined.[15,16,17]

There are many studies, both domestic and international, on the classification of DRGs diseases that discuss medical expenses and hospital management policies. However, so far, no study has taken outcome measures as a monitoring indicator of Tw-DRGs cases to explore its correlation with the financial performance of medical institutions. The NHIA has established monitoring indicators to prevent people's rights from being compromised in inpatient care. This study used the 14-day readmission rate, 3-day readmission rate to the emergency department of the same hospital, and the transfer rate as indicators of Tw-DRGs case monitoring, which is an important policy to monitor the quality of care after inpatient treatment discharge.

Nurses play an essential role in the medical system, but the world is facing a shortage of nursing workforce, and so is Taiwan. According to the Taiwan Union of Nurses Association (TUNA) in December 2020, the actual practice rate of people with nursing licenses in Taiwan is 59.9%, and nearly 40% of them do not want to work in nursing even after obtaining a nursing certificate. The shortage of nursing staff is not only because of the high nursing to sickness ratio but also because of salary and overtime work. If the nurse–patient ratio is too high, their health status and work pressure will have an impact on demission;[18,19] further, heavy workload will increase the physical and social pressure on nurses and will also encourage the intention of dismissal of nursing staff.[20,21]To improve the nursing practice environment, the Ministry of Health and Welfare has included the nurse–patient ratio as an official item in hospital evaluation and linked hospitalization insurance consultation compensation since 2015, and the nurse–patient law was formally legislated in 2019 . In recent years, several articles have been published in international nursing journals on nursing workforce issues in Taiwan,[22,23,24] but previous studies on dimission factors have tended to be

inferential in terms of dimission intention. In addition to the fact that the nurse–patient ratio and workload have been the focus of clinical nursing workforce demands in recent years, the nursing workload has been increasingly recognized as being related to labor turnover and shortage, as well as quality of care.

Furthermore,[25] indicated that achieving a safe nurse-to-patient ratio decreases turnover rates and saves on training costs; replacing a nurse costs an approximate US$42,000, and every 1% increase in the nurse turnover rate leads to an average annual additional cost of US$300,000 (PricewaterhouseCoopers' Health Research Institute, 2007). Turnover in nursing causes immense financial losses, so it is estimated that the cost of each lost is about US$44,380 to US$63,400.[26] Moreover, if the work pressure is too great, it will likely increase the physical and social pressure on the nursing staff and will make them more likely to change professions.[27,28] By the way,[29,30] has found that when nurses have fewer patients to care for, hospitals have a better financial performance and have support for them to improve the effectiveness of their operations.

In March 2021, the National Health Insurance Administration announced the financial report of hospitals that received health insurance costs of more than 200 million TWD in 2019. Hospital income is mainly divided into two categories: "medical income" and "non-medical income". Medical income is the main source of income for hospitals. Due to the rapid aging of the population and the continuous expansion of medical hardware resources, as well as the implementation of total budget control by the National Health Insurance, the operating environment of hospitals has become increasingly difficult. Most of the medical care systems of public and private hospitals in Taiwan have faced the same medical payment standard under the medical system formulated by the government. Therefore, improving the operation performance of hospitals and enhancing their competitive advantage has become the most important topic for various healthcare systems.[31,32,33] And the performance indicators of hospital operating performance: (1) Financial performance indicators: such as return on assets; (2) Operating performance indicators: such as occupancy Rate; (3) Marketing performance indicators: such as admission market share.[34,35,36] There are many factors that affect hospital performance, such as cost behavior, management orientation, and quality of care, as well as the performance indicators of medical institutions. Further, previous literature has shown that most people believed that the implementation of DRGs has an impact on hospital finance, which makes hospital operation increasingly difficult and has varied degrees of financial impact on different levels of hospitals. Hospital financial reports can help the public and users of financial statements to interpret and supervise.

Considering the impact of COVID-19 on the finance of medical institutions, the financial report of 2020 will be made public in early 2022. Therefore, this study selected public hospitals as its object. It compares the health insurance points, Tw-DRGs, the nurse–patient ratio, and the hospital financial performance before and after the start of COVID-19. This paper used data from the insurance provider's point-of-service reporting to measure the effectiveness of the Tw-DRGs case monitoring indicators: 14-day readmission rate, 3-day readmission rate to the emergency department of the same hospital, and transfer rate. Meanwhile, we reviewed the changes in reporting differences and further analyzed the differences between various hospital levels. The net interest rate was used as a financial performance indicator for medical institutions to understand whether the financial situation of hospitals would be affected during the 2 years before and after the start of COVID-19 and to help the authorities plan and

coordinate the allocation of Taiwan's medical resources.

METHOD

Design and object of study

In 2021, NHIA announced the financial reports of 223 hospitals receiving health insurance premiums of more than 200 million TWD in 2019, including 19 medical centers, 81 regional hospitals, 120 district hospitals, and 3 primary clinics. To explore whether the financial status of hospitals before and after COVID-19 would be affected, the study period was 2019–2020. However, considering the impact of COVID-19 on the financial situation of medical institutions, the financial report of 2020 will be made public in early 2022. Considering that the government and its subordinate organs handling various accounting affairs are prepared by public institutions in accordance with the provisions of the accounting body and approved by the auditing body, public hospitals are required by the government to publish an annual report on their website, and the content of the annual report is consistent with the financial report released by the medical service organization of the NHIA. This study adopts a retrospective study design, and regression analysis as a statistical analysis tool. The study subjects were mainly 61 public hospitals in Taiwan, comparing the medical quality monitoring indicators and net profit ratios of financial performance in 2019 and 2021.

STUDY TOOLS

Hospital financial performance indicator: net profit margin (*NPM*)

The NPM was used to measure the profitability of hospitals—that is, the ratio of the profit and loss of the public hospital to the medical revenues in a given year.

Health insurance points: The difference in the average of all medical claims in the previous year (*HIP_D*)

To effectively control the growth of medical resources and reduce the financial deficit, NHIA fully implemented the global budget system of hospitals at all levels in 2002. The global payment system refers to a specific range of health insurance points between the payer (NHIA) and the medical provider. Several reforms, including the global budget payment system, the 2nd Generation NHI, and Taiwan diagnosis-related groups, are all for the sustainable operation of health insurance.[36,37] Health insurance points reflect the cost of various services in terms of relative points, but the amount paid per point is calculated retrospectively by dividing the global budget by the actual total number of services points. Although the global budget is a fixed value, its point value is a floating system; thus, the total amount of medical expenses can be accurately controlled. Microsoft Excel was used as the data editing software to calculate the monthly reporting of medical service points in each hospital. The data source was the "Monthly Reporting Point Disclosure for Hospitals" of the NHIA, and the difference between the averages of all medical reporting points in the previous year was used as the measure of medical service points in this study.

Taiwan diagnosis-related groups (*Tw-DRGs*)

Tw-DRGs were divided into different groups based on the diagnosis, operation or treatment, age, complications, and discharge status of inpatients. According to the use of medical resources by each group, the payment points for one

hospitalization of each group were determined in advance, and additional benefits were designed for specific items. The advantage was that the autonomy of the medical profession was greatly improved; physicians were able to follow clinical care guidelines to improve treatment efficiency, reduce unnecessary hospitalization days, effectively control medical expenses, and improve patient care quality and efficacy. The purpose of Tw-DRGs policy is to improve the efficiency of medical services, as well as care quality and efficacy. The implementation of Tw-DRGs under the global payment system is also a great challenge for hospital operators . This paper used data from the insurance provider's point-of-service reporting to measure the effectiveness of the Tw-DRGs case monitoring indicators: 14-day readmission rate (*DRG14*), 3-day readmission rate to the emergency department of the same hospital (*DRG3*), and transfer rate (*DRGT*), where DRG14 was the number of cases discharged from the Tw-DRGs that were readmitted within 14 days; DRG3 was the rate of cases discharged from the hospital and the rate of cases readmitted to the same hospital within 3 days; and DRGT was the rate of cases with a transfer code matching "6 transfer" in the Tw-DRGs. The outcome measures originally included the average length of stay, but because its data was only updated to 2019, the average length of stay was not within the scope of this study. Further, the differences between the three indicators of each hospital and their respective regional practice group indicators and national indicators were further analyzed, namely, the difference between the indicator value of 14-day readmission rate and the indicator value of their respective regional practice group (*DRG14D1*), as well as the difference between the indicator value of 14-day readmission rate and the national indicator value (*DRG14D2*); the difference between the indicator value of 3-day readmission rate to the emergency department of the same hospital and the indicator value of their respective regional practice group (*DRG3D1*), as well as the difference between the indicator value of 3-day readmission rate to the emergency department of the same hospital and the national indicator value (*DRG3D2*); and the difference between the indicator value of transfer rate and the indicator value of their respective regional practice group (*DRGTD1*), as well as the difference between the indicator value of transfer rate and the national indicator value (*DRGTD2*).

Nurse–patient ratio (*NP_P*)

Nurse–patient ratio refers to the average number of patients cared for by each nursing staff in the hospital; it is calculated as follows: the number of hospital beds × bed occupancy × 3 ÷ the total number of nurses working three shifts per day. The average daily nursing ratio for each month was recorded by the NHIA contracted hospitals using the Virtual Private Network (VPN) login. The shortage of nursing staff is a common problem in all countries. Not only Taiwan, but many European countries and Japan also have exceeded the best nurse–patient ratio of 1:6. However, Taiwan is at a concerning position in the overall ranking. Its nurse–patient ratio is more than twice the standard value. The Department of Medical Affairs, Ministry of Health and Welfare, announced the establishment of standards for medical institutions, regulating the maximum number of patients

cared for by hospital nursing staff, with 1 nurse practitioner caring for 9 patients in medical centers, 1 to 12 in regional hospitals, and 1 to 15 in district hospitals. The Ministry of Health and Welfare stressed that the health insurance linkage incentive mechanism has been launched. If a hospital meets the evaluation standard of the nurse–patient ratio, it can increase the number of health insurance benefits, hoping to reduce the explosion of the nurse–patient ratio. It is recommended to monitor the post-discharge medical utilization and outcomes of inpatients in

healthcare institutions to ensure the quality and efficacy of patient care and to track whether the quality of inpatient care decreases because of less consumption of medical resources or shorter hospitalization days [37].

Data collection methods and statistical analysis

In this study, SPSS 20.0 software package was used for the statistical analysis of data. The statistical methods used were descriptive statistics, such as percentage, mean, and standard deviation. The difference between the 2 years before and after the start of COVID-19 was verified using independent t-test, and Pearson's correlation coefficient was used to test the correlation between *HIP_D*, Tw-DRGs case monitoring indicators (*DRG14*, *DRG3*, and *DRGT*) *NP_P* and *NPM*. Finally, the significant predictors of hospital financial performance were analyzed using the linear regression model.

RESULTS

Basic properties of the research object

In the data analysis table of 122 public medical institutions, there were 61 in 2019 and 2020, of which most hospitals were district hospitals (50.82%), followed by regional hospitals (39.34%). In the profit attribute of medical institutions, the hospitals with surplus accounted for the majority. A total of 108 hospitals had profits (88.52%), and another 14 hospitals (11.48%) had signs of deficit. Further, according to the annual detailed analysis, 52 hospitals showed positive operating revenue in 2019, and the number of profitable hospitals increased to 56 by 2020, indicating that COVID-19 did not affect the operation of hospitals because they showed stable growth (Table 1).

Table 1: *Samples (N = 122)*

Type	N	%
Year		
2019	61	50
2020	61	50
Net Profit Margin		
Gain	108	88.52
Loss	14	11.48
2019		
Gain	52	85.25
Loss	9	14.75
2020		
Gain	56	91.8
Loss	5	8.2
Classify		
Medical Centers	12	9.84
Regional Hospitals	48	39.34
District Hospitals	62	50.82

Note. According to hospital evaluation conducted by the Ministry of Health and Welfare, medical institutions can be

divided into three levels: district hospitals, regional hospitals and medical centers.

(Table 2) showed the results of descriptive statistical analysis of *HIP_D*, case monitoring indicators of Tw-DRGs (14-day readmission rate, 3-day readmission rate to the emergency department of the same hospital, and transfer rate), *NP_P*, and *NPM*, which were further verified by t-test. The results showed that the average value of *NPM* (4%) in 2020 was higher in terms of financial performance; compared with 2020, the average value in 2019 (9818952 points) was higher for the difference in the reported points; among the Tw-DRGs case monitoring indicators, *DRG14* (11%) and *DRG3* (6%) had high average values in 2019; the average of *NP_P* in 2020 (9.73/ person) was lower than that in 2019 (9.88/ person), indicating an improving trend of *NP_P*. There were statistical differences between *NP_P* and *NPM*, *HIP_D*, *DRG14*, and *DRG3* in the 2 years of before and after the start of COVID-19.

Table 2 *Summary of Statistics (N = 122)*

	2019 (n=61)		2020 (n=61)			
Variables [a]	**Mean**	**Std. Dev**	**Mean**	**Std. Dev**	***t***	***p*** [b]
NPM	0.03	0.05	0.04	0.03	-0.8	0.03**
HIP_D	9818952	3.48	79565818	3.04	3.82	0.00***
DRG14	0.11	0.08	0.1	0.08	0.27	0.06*
DRG3	0.06	0.04	0.05	0.04	-0.4	0.08*
DRGT	0.04	0.06	0.03	0.04	-0.8	0.44
DRG14D1	0.03	0.07	0.03	0.07	0.3	0.77
DRG14D2	0.03	0.07	0.04	0.07	0.37	0.71
DRG3D1	0.01	0.03	0.01	0.03	-0.1	0.91
DRG3D2	0.01	0.03	0.01	0.03	-0.4	0.67
DRGTD1	0.02	0.03	0.01	0.03	-0.2	0.85
DRGTD2	0.02	0.03	0.01	0.04	-0.2	0.87
NP_P	9.88	2.02	9.73	2.19	-0.4	0.09*

[a] *NPM*: net profit margin; *HIP_D*: the difference in the average of all medical claims in the previous year; *DRG14*: the number of cases discharged from the Tw-DRGs that were readmitted within 14 days; *DRG3*: the rate of cases discharged from the hospital and the rate of cases readmitted to the same hospital within 3 day; *DRGT*: the rate of cases with a transfer code matching "6 transfer" in the Tw-DRGs; *DRG14D1*: the difference between the indicator value of 14-day readmission rate and the indicator value of their respective regional practice group; *DRG14D2*: the difference between the indicator value of 14-day readmission rate and the national indicator value; *DRG3D1*: the difference between the indicator value of 3-day readmission rate to the emergency department of the same hospital and the indicator value of their respective regional practice group; *DRG3D2*: the difference between the indicator value of 3-day readmission rate to the emergency department of the same hospital and the national indicator value; *DRGTD1*: the difference between the indicator value of transfer rate and the indicator value of their respective regional practice group; *DRGTD2*: the difference between the indicator value of transfer rate and the national

indicator value; *NP_P*: Nurse–patient ratio.

[b] *$p < .10$. ** $p < .05$. *** $p < .01$.

Correlation analysis of *HIP_D*, Tw-DRGs case monitoring indicators (*DRG14*, *DRG3*, and *DRGT*), N*P_P*, and *NPM*

The values of Pearson correlations are shown in (Table 3). There were significant negative correlations between *NPM* and *DRG3*, *DRG3D1* and *NP_P* ($p < .05$), and significant positive correlations between *NPM* and *DRGTD1* and *DRGTD2* ($p < .05$). That is, the lower *DRG3*, the smaller the gap of *DRG3D1*, the less the *NP_P*, the higher the *NPM*; the larger the gap between D*RGTD1* and *DRGTD2*, the higher the *NPM*.

Table 3: Correlation Matrix (N = 122)

Variables [a,b]	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1. *NPM*	1											
2. HIP_D	0.12	1										
3. DRG14	-0.02	-0.15	1									
4. DRG3	-.17*	-.16*	0.13	1								
5. DRGT	-0.13	-.16*	.21*	.43*	1							
6. DRG14D1	0.01	-.17*	.63*	0.05	0.14	1						
7. DRG14D2	0	-.19*	.54*	0.07	.15*	.69*	1					
8. DRG3D1	-.16*	-0.14	-0.1	.67*	.20*	0.01	0.02	1				
9. DRG3D2	-0.14	-.16*	0.05	.64*	.18*	0.13	0.12	.02*	1			
10. DRGTD1	.14*	-0.13	.31*	.25*	.63*	.28*	.29*	.17*	.16*	1		
11. DRGTD2	.14*	-.21*	-0	.30*	.25*	.63*	.27*	.27*	.17*	.15*	1	
12. NP_P	-.30*	-.26*	-0.1	.22*	0.09	0.03	0.05	.23*	.24*	-0	-0	1

[a] *NPM*: net profit margin; *HIP_D*: the difference in the average of all medical claims in the previous year; *DRG14*: the number of cases discharged from the Tw-DRGs that were readmitted within 14 days; *DRG3*: the rate of cases discharged from the hospital and the rate of cases readmitted to the same hospital within 3 day; *DRGT*: the rate of cases with a transfer code matching "6 transfer" in the Tw-DRGs; *DRG14D1*: the difference between the indicator value of 14-day readmission rate and the indicator value of their respective regional practice group; *DRG14D2*: the difference between the indicator value of 14-day readmission rate and the national indicator value; *DRG3D1*: the difference between the indicator value of 3-day readmission rate to the emergency department of the same hospital and the indicator value of their respective regional practice group; *DRG3D2*: the difference between the indicator value of 3-day readmission rate to the emergency department of the same hospital and the national indicator value; *DRGTD1*: the difference between the indicator value of transfer rate and the indicator value of their respective

regional practice group; *DRGTD2*: the difference between the indicator value of transfer rate and the national indicator value; *NP_P*: Nurse–patient ratio.

[b] Pearson correlations in the lower diagonal. * Indicates significance at the 5 percent level.

Analysis of influencing factors of hospital financial performance before and after the start of the COVID-19 pandemic

(Table 4) shows the impact of *HIP_D*, case monitoring indicators of Tw-DRGs (14-day readmission rate, 3-day readmission rate to the emergency department of the same hospital, and transfer rate), and *NP_P* on hospital financial performance in the post-pandemic era. This study divided the study samples into before and after the start of the COVID-19 pandemic for analysis. The results showed that in 2019, only *NP_P* was negatively correlated with *NPM* (t=-4.23, $p < .01$); among the sample groups in 2020, *HIP_D* showed a significant positive correlation (t=2.57, $p <. 01$), while *DRG3* (t=-2.11, $p < .05$), *DRG3D1* (t=-2.16, $p < .05$), and *DRGD2* (t=-2.35, $p < .05$), which were the predictors of hospital net profit margin, showed a significant negative correlation; that is, the smaller the *DRG3*, *DRG3D1*, and *DRG3D2*, the greater the *HIP_D* and the lower the *NP_P*, the better the profit trend of the hospital.

Table 4: Independent Variables Linear Regression with Net Profit Margin

	2019 (61)		**2020 (61)**	
Variables [a]	**β**	***t* [b]**	**β**	***t***
HIP_D	2.94	0.61	6.06	2.57***
DRG14	-0	-0.5	0.02	0.56
DRG3	-0.2	-1.04	-0.2	-2.11**
DRGT	-0.1	-1.14	-0	-0.81
DRG14D1	-0	-0.42	0.06	1.14
DRG14D2	-0.1	-0.55	0.05	0.99
DRG3D1	-0.2	-0.96	-0.2	-2.16**
DRG3D2	-0.1	-0.61	-0.3	-2.35**
DRGTD1	-0.3	-1.1	-0.1	-1.09
DRGTD2	-0.3	-1.19	-0.1	-1.08
NP_P	-0	-4.23***	0	-0.4

[a] *HIP_D*: the difference in the average of all medical claims in the previous year; *DRG14*: the number of cases discharged from the Tw-DRGs that were readmitted within 14 days; *DRG3*: the rate of cases discharged from the hospital and the rate of cases readmitted to the same hospital within 3 day; *DRGT*: the rate of cases with a transfer code matching "6 transfer" in the Tw-DRGs; *DRG14D1*: the difference between the indicator value of 14-day readmission rate and the indicator value of their respective regional practice group; *DRG14D2*: the difference between the indicator value of 14-day readmission rate and the national indicator value; *DRG3D1*: the difference between the indicator value of 3-day readmission rate to the emergency department of the same hospital and the

indicator value of their respective regional practice group; *DRG3D2*: the difference between the indicator value of 3-day readmission rate to the emergency department of the same hospital and the national indicator value; *DRGTD1*: the difference between the indicator value of transfer rate and the indicator value of their respective regional practice group; *DRGTD2*: the difference between the indicator value of transfer rate and the national indicator value; *NP_P*: Nurse–patient ratio.

[b] Asterisks *, **, *** indicate two-tailed significance at the 0.10, 0.05, and 0.01 levels, respectively.

Analysis of related factors at the level of healthcare

According to hospital evaluation conducted by the Ministry of Health and Welfare, medical institutions can be divided into three levels: district hospitals, regional hospitals and medical centers. To test whether *HIP_D,* Tw-DRGs case monitoring indicators (*DRG14*, *DRG3*, and *DRGT*), and *NP_P* would affect the *NPM* of hospital financial statements, in this paper, the analysis was divided into different medical levels, and the research results are shown in (Table 5). The analysis results showed that *DRG14* (t = 2.29, p < .05), *DRG14D1* (t=2.56, p < .05), and *DRG14D2* (t=2.54, p < .05) had significant positive correlation with the hospital net profit margin of district hospitals in 2020, while in 2019, only *NP_P* and *NPM* showed significant differences (t=-3.66, p < .05), and there was no significant difference for the rest; in 2019, *DRG14* (t=-2.27, p < .05)、*DRG3* (t=-1.67, p < .10)、*DRG14D1* (t=-2.12, p < .05, and *DRG14D2* (t=-1.69, p < .10) in regional hospitals were significantly and negatively correlated, and only *DRG14* (t=-2.23, p < .05)was significantly correlated in 2020; *HIP_D* (t=1.00, p < .10) of medical centers in 2020 was significantly and positively correlated with the profitability of hospitals, and *DRG14* (t=-1.87, p < .10) and *DRG14D2* (t=-1.86, p < .10) had a significant impact. The results showed that different healthcare levels before and after the start of the COVID-19 pandemic had different effects on hospital financial performance.

Table 5: Independent Variables Linear Regression with Net Profit Margin- District Hospitals, Regional Hospitals and Medical Centers

	District Hospitals				**Regional Hospitals**				**Medical Centers**			
	2019		**2020**		**2019**		**2020**		**2019**		**2020**	
Variables [a]	**β**	***t*** [b]	**β**	***t***	**β**	***t***	**β**	***t***	**β**	***t***	**β**	***t***
HIP_D	-3	-0.76	-0.1	-0.17	3.8	0.94	1.78	0.43	-6.2	-0.1	3.19	1.00*
DRG14	-0	0.21	0.13	2.29**	-0.2	-2.27**	-0.1	-2.23**	-1	-0.8	-0.6	-1.87*
DRG3	-0.1	-0.38	-0.2	-1.05	-0.2	-1.67*	-0.1	-0.52	-1	-0.4	0.23	0.26
DRGT	-0.1	-0.55	-0.1	-0.34	-0.1	-1.15	0.03	0.49	1.2	0.07	-7.4	-1.09
DRG14D1	0.02	0.13	0.16	2.56**	-0.5	-2.12**	0.12	-0.97	-0.4	-0.3	-0.3	-0.98
DRG14D2	0.01	0.06	0.16	2.54**	-0.2	-1.69*	-0.1	-1.03	-1	-0.8	-0.6	-1.86*
DRG3D1	-0.1	-0.42	-0.2	-1.08	-0.4	-1.17	0.03	0.18	-1.2	-0.5	-0.1	-0.13
DRG3D2	-0	-0.09	-0.2	-1.2	-0.4	-1.31	0.03	0.15	-1	-0.4	0.23	0.26
DRGTD1	-0.2	-0.57	-0.1	-0.34	-0.2	-1.02	0.09	0.65	5.66	0.65	3.52	1.01
DRGTD2	-0.2	-0.55	-0.1	-0.37	-0.2	-1.09	0.07	0.61	1.2	0.07	-7.4	-1.09
NP_P	-0	-3.66**	0.01	0.06	-0	-0.49	0.01	0.51	-0	-0.5	-0	-0.79

[a] *HIP_D*: the difference in the average of all medical claims in the previous year; *DRG14*: the number of cases discharged from the Tw-DRGs that were readmitted within 14 days; *DRG3*: the rate of cases discharged from the hospital and the rate of cases readmitted to the same hospital within 3 day; *DRGT*: the rate of cases with a transfer code matching "6 transfer" in the Tw-DRGs; *DRG14D1*: the difference between the indicator value of 14-day readmission rate and the indicator value of their respective regional practice group; *DRG14D2*: the difference between the indicator value of 14-day readmission rate and the national indicator value; *DRG3D1*: the difference between the indicator value of 3-day readmission rate to the emergency department of the same hospital and the indicator value of their respective regional practice group; *DRG3D2*: the difference between the indicator value of 3-day readmission rate to the emergency department of the same hospital and the national indicator value; *DRGTD1*: the difference between the indicator value of transfer rate and the indicator value of their respective regional practice group; *DRGTD2*: the difference between the indicator value of transfer rate and the national indicator value; *NP_P*: Nurse–patient ratio.

[b] Asterisks *, **, *** indicate two-tailed significance at the 0.10, 0.05, and 0.01 levels, respectively.

DISCUSSION

In the evaluation of hospitals, district hospitals are only inferior to medical centers and regional centers. Moreover, because of the wide distribution and large number of district hospitals, it is more convenient to provide healthcare services. Therefore, in this study, district hospitals (50.82%) dominated the level of public hospitals. In the profit attribute of medical institutions, the average *NPM* of hospitals was 4%, and more than half (88.52%) the hospitals were profitable. This result is similar to the study results of[38] The increasing trend of the number of profitable hospitals in 2020 showed that COVID-19 does not have an impact on the operation efficiency of hospitals. Furthermore, the average number of reported point differences of 14-day readmission rate (*DRG14*) and 3-day readmission rate to the emergency department of the same hospital (*DRG3*) in 2019 was higher than those in 2020. In 2019, to improve the nursing practice environment, the National Health Insurance Administration (NHIA) included the ratio of nursing care in hospital evaluation items to improve the nursing practice environment and linked it to the increase of health insurance benefit, which has effectively established the regulation of the nurse–patient ratio in acute care institutions, and it was inferred that the average number of nursing–patient ratio in 2020 had a decreasing trend.

The Pearson correlation coefficient was used to analyze and discuss *HIP_D* (Health insurance points: the difference in the average of all medical claims in the previous year), Tw-DRGs case monitoring indicators (14-day readmission rate, 3-day readmission rate to the emergency department of the same hospital, and transfer rate), Nurse–patient ratio (*NP_P*), and net profit margin (*NPM*), which showed that net profit margin (*NPM*) was significantly correlated with *DRG3* (3-day readmission rate to the emergency department of the same hospital), *DRG3D1* (the difference between the indicator value of 3-day readmission rate to the emergency department of the same hospital and the indicator value of their respective regional practice group), Nurse–patient ratio (*NP_P*), *DRGTD1* (the difference between the indicator value of transfer rate and the indicator value of their respective regional practice group), and *DRGTD2* (the

difference between the indicator value of transfer rate and the national indicator value).

The development ecology of medical institutions in Taiwan is deeply affected by the health insurance benefits system. Because of the continuous increase of costs and the gradual reduction of operating profits, the overall medical income of hospitals is divided into self-payment and health insurance income. Under the health insurance system in Taiwan, most of the revenue of major hospitals comes from health insurance income, while the operating costs of hospitals are adjusted in line with the salary structure and price fluctuations. The biggest task of hospital operators is to improve the quality of healthcare services so that patients can receive fair and reasonable treatment. Additionally, reasonable fees should be charged so that the total medical income of the hospital is sufficient to pay for the salaries of employees, and then the surplus, if any, can be used to replace equipment and purchase advanced equipment. On the other hand, poor financial performance has a direct impact on the quality of healthcare services provided and citizens' access to them, as it often leads to a reduction of services and hospital shutdowns.[39] Indeed, a related study conducted in the US found a strong positive correlation between financial performance and quality of care provided.[40] On the other hand, hospitals characterized by significantly lower profit margins are considered more susceptible to potential economic pressures from the external environment.[41] There are many factors affecting the hospital operating performance in the market, so this paper referred to previous works that used the net profit margin as the financial performance indicator to measure the profitability of hospitals.[42] The financial performance, management orientation, and medical quality of hospitals can be interpreted and supervised by the public through the disclosure of financial statements, which helps authorities to plan and coordinate the allocation of medical resources in Taiwan.

Thus, this study first compared the values of indicators 2 years before and after the start of COVID-19 from 2019 to 2020. The items discussed included the health insurance points, hospital scale correlation index, Tw-DRGs (14-day readmission rate, 3-day readmission rate to the emergency department of the same hospital, and transfer rate), and the analysis of the impact of business performance including Nurse–patient ratio (*NP_P*) shown in Table 4. The study showed that the difference between the average point of all medical claims in the year before 2020 (HIP_D) and the net profit margin (*NPM*) has a significant impact. This indicates that although Table 2 showed that the average number of HIP_D (Health insurance points: the difference in the average of all medical claims in the previous year) claims in 2020 was lower than in 2019, the reason was that the number of visits in 2020 was reduced because of the impact of COVID-19. The inpatient population at all levels of medical institutions was reduced by nearly 20% compared to 2018 and 2019, but the health insurance covered the same hospital costs as the same period in 2019, which meant that hospitals could reasonably allocate health insurance resources and reduce unnecessary medical costs, while improving the service quality of the hospital, controlling the cost, and maintaining efficacy. Therefore, this study speculated that good disease diagnosis can reduce follow-up cost, enable the hospital to complete the treatment under the limited payment limit, and improve the financial performance of the hospital.

Under the Tw-DRGs system, patients are categorized by their main diagnosis, where the National Health Insurance Administration (NHIA) determines the amount of benefits for patients in the overall treatment process based on the results of the categorization. However, in practice, patients often need to be hospitalized repeatedly to recover, and patients' costs are repeated, which highlights the importance of improving medical outcomes. The channel for

medical service providers to improve medical effectiveness can be through strengthening the diagnosis of patients' diseases. Detailed diagnostic records not only reduce the risk of submitting data for review but also reduce unnecessary testing and dispositions, as well as the length of hospital stay. For medical care providers, a more efficient service delivery model will reduce the workload and improve the signs of workforce shortage. It is recommended to monitor the post-discharge medical utilization and outcomes of inpatients in healthcare institutions to ensure the quality and efficacy of patient care and to track whether the quality of inpatient care decreases because of less consumption of medical resources or shorter hospitalization days. Therefore, the Tw-DRGs case monitoring indicators (*DRG14*, *DRG3* and *DRGT*) were used as outcome indicators for the analysis in this study. To control medical expenditures, the NHIA has divided the global payment business into six business groups (Taipei business group, North district business group, Central business group, South district business group, Kaohsiung &Pingtung business group, East district business group), and each business group has different numbers of medical institutions, resulting in varied levels of competition, which have distinct effects on the operation of medical institutions. Only in 2020, *DRG3* (the rate of cases discharged from the hospital and the rate of cases readmitted to the same hospital within 3 day), *DRG3D1* (the difference between the indicator value of 3-day readmission rate to the emergency department of the same hospital and the indicator value of their respective regional practice group), and *DRG3D2* (the difference between the indicator value of 3-day readmission rate to the emergency department of the same hospital and the national indicator value) showed a significant negative correlation, which means that when hospitals invest more in early diagnosis, it would decrease the complexity of follow-up treatment, reduce unnecessary expenses, and lower the 3-day readmission rate to the emergency department of the same hospital to maintain the financial performance of hospitals. Furthermore, when the indicator value of the hospital was smaller than the regional or national indicator value, it meant that 3-day readmission rate to the emergency department of the same hospital was lower than that of other hospitals, and the quality of medical services was better. This indicates that when hospitals invest in more or better-quality diagnoses, the accuracy of diagnoses improves, which helps to control the follow-up costs of treating patients and reduce the risk of treatment failure and follow-up costs, thus improving the financial performance of hospitals. Therefore, through the monitoring mechanism, the medical cost can be effectively reduced. There is no obvious localization of transferred cases in a single hospital. It is inferred that the quality of inpatient diagnosis and treatment has not been affected by the low consumption of resources and less inpatient days.

The shortage of nursing workforce not only causes the high turnover rate and low satisfaction of nursing staff but also directly affects the health results of patients and hospital costs. Generally, the higher the nurse–patient ratio, the more negatively the patient outcomes are affected by insufficient nursing workforce, including increased human error, lower patient satisfaction, and increased family complaints. Studies have shown that if the reasonable allocation of clinical nursing workforce is reduced because of economic considerations, it often leads to a decline in the quality of medical care for patients, which in turn affects the medical income of the hospital.[43,44, 45] If there is an overload of healthcare workers, Taiwan's existing medical workforce may not be able to cope with an epidemic outbreak. The Ministry of Health and Welfare formally legislated the nurse–patient law in 2019, included rules regarding the nurse–patient ratio in the hospital evaluation items and linking it to health insurance benefits. This

study found that the nurse–patient ratio in 2019 had a significant impact. This may be because after the nurse–patient ratio was legislated in that year, the Ministry of Health and Welfare pointed out that the hospitals that did not meet the standard had a 2-month deadline to improve and that those who failed to improve would be rated as disqualified. It showed that the nursing staff could improve the hospital's operating efficiency by caring for fewer patients. However, because of the COVID-19 pandemic in 2020, the number of people seeking medical treatment decreased, so it did not reach a significant correlation.

This study classified hospitals into three levels, according to the evaluation standards of the Ministry of Health and Welfare—namely medical centers, regional hospitals, and district hospitals—and compared and analyzed the operational efficiency of the three different hospital levels. As district hospitals receive more patients with mild diseases, the medical treatment of patients is relatively less complicated, and the consumption of medical resources in regional hospitals is less. Because the nurse–patient ratio was legislated in May 2019, district hospitals had a low nurse–patient ratio in 2019, where nursing staff cared for fewer patients, and the hospital income was positive.

In 2020, district hospitals were shown that the higher the *DRG14* (the number of cases discharged from the Tw-DRGs that were readmitted within 14 days), *DRG14D1* (the difference between the indicator value of 14-day readmission rate and the indicator value of their respective regional practice group), and *DRG14D2* (the difference between the indicator value of 14-day readmission rate and the national indicator value), the better the hospital return. It was speculated that the 14-day readmission rate would increase, and some patients may be readmitted within 14 days because of their physical condition or conditions that require chemotherapy, rehabilitation, or anticipated surgery. Therefore, continuous observation and follow-up will be carried out. The indicator value of the district hospitals was greater than the regional or national indicator value, indicating that the 14-day readmission rate in the hospital was higher than that of other hospitals, and the hospital had poor quality of medical service. The trend of lower 14-day readmission rates in regional hospitals for both 2 years before and after the start of COVID-19 was because hospitals maintained their financial performance by investing more in early diagnosis, reducing the complexity of follow-up treatment, and decreasing the 14-day readmission rate to lower unnecessary expenditures. In 2019, when the indicator value of the hospital was less than the regional or the national index value (*DRG14D1* and *DRG14D2*), it meant that the 14-day readmission rate in the hospital was lower than that of other hospitals, and the medical service quality is better, indicating that when the hospital invests more or better disease diagnosis, the accuracy of disease diagnosis is improved, which helps to control the follow-up cost of treating patients, reduce the risk of treatment failure and follow-up cost expenditure, and improve the financial performance of the hospital.

The global budget payment system of health insurance in Taiwan is shared by all medical circles. If graded medical care can be implemented, medical resources can be used more efficiently, acute and severe patients can go to large hospitals, and the congestion of emergency and hospitalization can be relieved, so that patients can receive timely and adequate care. Because of the different intensity of competition among hospitals in each medical area, the operation of the medical center is more effective than that of regional hospitals and district hospitals, indicating that the patients handled by the medical center belong to the group with complicated conditions and high consumption of medical resources, where medical centers handle most of the complicated cases, followed by regional hospitals and district hospitals, respectively. Therefore, the consumption of medical resources in the medical center is higher than

that in other hospitals. The medical center not only plays the most important role in teaching, research, and medical treatment but also has the function of promoting medical institutions with other levels. Therefore, compared with the previous year, the medical center applied for fewer healthcare service points in the era of the pandemic, after 2020. Based on the monitoring mechanism, there is no obvious concentration of cases transferred out of a single hospital, so it is inferred that the quality of inpatient treatment was not affected by the low consumption of resources and short duration of hospitalization. With the advantages of medical technology and practice, the medical center not only has better medical quality, enhanced cost control, and reduced unnecessary expenses but also new medical equipment and expanded income from non-medical activities, effectively improving financial efficiency and reducing medical costs through the monitoring mechanism. However, the transferred cases are not evidently localized in a single hospital level. It was inferred that the quality of inpatient treatment is not affected by the low consumption of resources and less hospitalization days. As the section of health insurance expenses is moving from medical institutions to pharmacies year by year, medical institution operations must reduce expenses through economies of scale to maintain operations. Public hospital consolidation will be given to private medical institutions to enable better operation; further, the brand effect of hospital operations in the medical center operating model can be more effective.

CONCLUSION

Based on the experience of fighting SARS epidemic in 2003, Taiwan developed a complete set of epidemic prevention mechanisms. Therefore, at the beginning of the outbreak of COVID-19, Taiwan immediately adopted a series of important epidemic prevention measures and used big data analysis and digital technology to prevent its spread. The foundation of epidemic prevention and stability lies in the 25 years of the implementation of the healthcare system in Taiwan. The achievements of the national health insurance in Taiwan have been highly praised internationally. However, recently, because of the shortage of nursing workforce, acute care institutions have growing numbers of reduced beds and closed wards. Nursing work is overloaded and stressful, and there is a disproportion between salary and labor, so the shortage of nursing workforce in Taiwan has been a concern for all walks of life.

The healthcare service points; Tw-DRGs case monitoring indicators (14-day readmission rate, 3-day readmission rate to the emergency department of the same hospital, and transfer rate); and nurse–patient ratio have different impacts on the financial performance of different medical levels. In 2019, the average daily nurse–patient ratio was formally legislated. After the rights were protected, it was speculated that it could increase the medical income of the hospital. The financial status of the medical center after COVID-19 was not affected by the pandemic. Therefore, the medical center showed a lower 14-day readmission rate and had higher health insurance benefits and better profitability.

This study was limited to public medical institutions. If the sample source can be expanded, it will have more inferential significance. Because COVID-19 has had a significant impact worldwide, this study used the data interval of 2 years before and after the start of COVID-19, hoping to add the analysis of the Omicron epidemic period and analyze the annual trend to understand the impact of the Omicron epidemic on the hospital's financial

situation, which will help managers plan and coordinate the allocation of medical resources in the follow-up study to improve completeness in Taiwan. Further, outcome measures were used as the Tw-DRGs case monitoring indicators, and its limitation was that the indicator calculation was based on the reported data of health insurance cost, considering that the field of the healthcare expense declaration is limited, which cannot reflect the complete process and result of healthcare. Because of multiple reasons, the performance of indicators may only present partial results or outcomes, and the healthcare suitability still needs to be recognized by the healthcare profession according to each patient's condition. Furthermore, due to different hospital scales, internal governance, participating in hospital management, salary system design, hospital performance indicators and hospital locality that may interfere with the business model and affect hospital financial performance, which is a limitation of this study.

It is suggested that future studies should explore the classification of medical institutions into the two major categories of public and private hospitals; classification of hospitals into hospital affiliations according to medical law; distribution of standard deviations among hospitals at each level; classification of hospitals into hospital ownership according to medical law that can be divided into Hospitals Subordinate to DOH and Municipal Hospitals, County & City Hospitals, Hospitals Affiliated with Public Medical Schools, Civilian Clinics of Military Hospitals, Veterans Hospitals (VACRS), Hospitals Affiliated with Enterprises, Private Hospitals, Non-Profit Proprietary Hospitals, Hospitals Affiliated with Non-Profit Proprietary Religious Organizations, Hospitals Affiliated with Medical Schools, and Hospitals Affiliated with Other Non-Profit Proprietary Organizations; and distribution of standard deviation among hospitals with different ownership at each level.

The development ecology of medical institutions in Taiwan is deeply affected by the health insurance benefit system. Hospitals have different degrees of impact on the operation of medical institutions because of the continuous increase of costs and the gradual decrease of operating profits. In the future, we can also refer to the indicators of financial performance: the ratio of personnel expenses to medical costs, the ratio of health material expenses to national health insurance income, and the turnover rate of intensive care beds. Furthermore, we can help managers understand whether the allocation of internal resources has been fully and effectively utilized by taking financial performance as a measurement indicator. In terms of future studies, we suggest that comparisons of operational efficiency can be made among peer hospitals in Taiwan to obtain more accurate extrapolative conclusions.

REFERENCE

1. Chiang TL, Wen YP, Hsieh CR. Progress and problems of Taiwan's national health insurance. Formosan Journal of Medicine 2014;18(1):33-42.
2. Lee YC, Huang YT, Huang KH, Yeh LL, Chen PC. The review and prospect of the national health insurance payment system reform. Formosan Journal of Medicine 2014;18(1):53-66.
3. Lu CC. A study of spatial model on the expenditure of medical and health care in Taiwan. Journal of Business 2010;18:77-106.
4. Yang MC, Lee CT, Chiou SJ. Time series analysis of the impact of supply and demand side cost containment policies on NHI medical expenditure. Taiwan Journal of Public Health 2004;23(5):377-387.
5. Yan YH, Hsu SF, Fang SC, Sun HY. Healthcare expenditure forecast model for a global budget system-A

case study in a Teaching hospital. Cheng Ching Medical Journal 2009;5(2):15-21.

6. Cheng SH, Chen CC, Tsai SL. The impacts of DRG-based payments on health care provider behaviors under a universal coverage system: A population-based study. Health Policy 2012;107(2):202-208.
7. Schuetz P, Albrich WC, Suter I, Hug BL, Christ-Crain M, et al. Quality of care delivered by fee-for-service and DRG hospitals in Switzerland in patients with community-acquired pneumonia. Swiss Med Wkly 2011;18(141):w13228.
8. Goldfield N. The evolution of diagnosis-related groups (DRGs): from its beginnings in case-mix and resource use theory, to its implementation for payment and now for its current utilization for quality within and outside the hospital. Quality Management in Health Care 2010;19(1):3-16.
9. Lo YT, Chang GM, Tung YC. Impact of the DRG-Based prospective payment system on medical utilization and outcomes of care for hip fracture and Hip replacement. Taiwan Journal of Public Health 2015;34(2):180-192.
10. Endrei D, Zemplényi A, Molics B, Ágoston I, Boncz I. The effect of performance-volume limit on the DRG based acute care hospital financing in Hungary. Health Policy 2014;115(2-3):152-156.
11. Huang RD, Ker CG, Lan SJ, & Yen YY. A study of influence of ICD-Coding quality on medical payments to the department of surgery. Medical Journal of South Taiwan 2011;7(2):94-103.
12. Huang WM, Wang YH. Chen T, Lee YH. An empirical study on the Diagnosis Related Groups information system in Taiwan. Journal of Medical and Health Information Management 2013;12(2):27-46.
13. Liu WW, Lin WH, Ding YP, Hsu WH, Tseng LT. Evaluating hospital performance for implementation of the Tw-DRGs on orthopedics in an armed force hospital. Pao-Chien Journal of Healthcare and Management 2013;11(1):16-30.
14. Hung YS. The impact of Tw-DRGs-based payment system of National Health Insurance on patient selection [Dissertation]. Taipei: Institute of Health and Welfare Policy, National Yang-Ming University. 2012.
15. Chen PC, Kuo RN, Huang YT, Huang KH, Yang MC, et al. Impact of DRG-based payments on health care providers. Taiwan J Public Health 2016;35(3):268-280.
16. Kuo KM. Impact of TW-DRGs payment system on medical care utilization, provider's behavior and medical care quality using coronary artery bypass graft surgery as an example. Taipei: Institute of Health Policy and Management, National Taiwan University. 2012.
17. Busato A, Below GV. The implementation of DRG-based hospital reimbursement in Switzerland: A population-based perspective. Health Research Policy and Systems 2010;8(1):16-31.
18. Asakura K, Asakura T, Satoh M, Watanabe I, Hara Y. Health indicators as moderators of occupational commitment and nurses' intention to leave. Japan Journal of Nursing Science 2020;17(1):e12277.
19. Aiken LH, Sloane DM, Bruyneel L. Nurse staffing and education and hospital mortality in nine European countries: A retrospective observational study. The Lancet 2014;383(9931):1824-1830.
20. Lanz JJ, Bruk-Lee V. Resilience as a moderator of the indirect effects of conflict and workload on job outcomes among nurses. Journal of advanced nursing 2017;3(12):2973-2986.

21. Salam M, Alghamdi KS. Nurse educators: Introducing a change and evading resistance. Journal of Nursing Education and Practice 2016;6(11):80-83.
22. Chang C.M, Lin HF. A study on the turnover behavior factors and workload of nursing staff. Chang Gung Nursing 2020;32(1):18-31.
23. Chang Y P, Lee DC, Chang SC, Lee YH, Wang HH. Influence of work excitement and workplace violence on professional commitment and turnover intention among hospital nurses. Journal of Clinical Nursing 2019;28(11-12):2171-2180.
24. Hung SY, Wu TH. An extended dea model for hospital performance evaluation considering medical manpower shortage and quality of care: taking acute care hospitals in Taiwan as examples. Journal of Business Administration 2019;44(4):57-89.
25. Aiken LH, Sloane DM, Cimiotti JP, Clarke SP, Flynn L, et al. Implications of the California nurse staffing mandate for other states. Health Services Research 2010;45(4):904-921.
26. Yarbrough S, Martin P, Alfred D, McNeill C. Professional values, job satisfaction, career development, and intent to stay. Nursing Ethics 2017;24(6):675-685.
27. Halter M, Pelone F, Boiko O, Beighton C, Harris R, et al. Interventions to reduce adult nursing turnover: A systematic review of systematic reviews. The Open Nursing Journal 2017;11:108-123.
28. Chang YR, Hsieh LH, Su WK. Improving the key factors of nursing staff's intention to stay. Changhua Nursing 2017;24(3):27-38.
29. Gao QL, Lin CS, Huang YT. Effects of nurse-to-patient ratios, hospital management, and health-care quality indicators in Taiwan. Journal of Business and Economic Management 2022;10(2):21-32.
30. Lin CC, Huang YT, Gao QL, Lin CS. An analysis of the correlation between financial performance and the nurse-patient ratio: Evidence from different hospital levels in Taiwan. International Review of Accounting, Banking and Finance 2022;14(1):27-40.
31. Berger M, Sommersguter-Reichmann M, Czypionka T. Determinants of soft budget constraints: How public debt affects hospital performance in Austria. Social Science and Medicine 2020;249:1-11.
32. Karim SA, Pink GH, Reiter KL, Holmes GM, Jones CB. Et al. The effect of the magnet recognition signal on hospital financial performance. Journal of Healthcare Management 2018;63(6):e131-e146.
33. Yan YH, Yang CW. Hospital governance mechanisms and hospital governance effectiveness. NTU Management Review 2013;23(S1):57-82.
34. Dong GN. Performing well in financial management and quality of care. BMC Health Services Research 2015;15(1):45.
35. Bem A, Predkiewicz K, Predkiewicz P, Ucieklak-Jez K. Determinants of hospital's financial liquidity. Procedia Economics and Finance 2014;12(2014):27-36.
36. Chang RE, Lin SP, Aron DC. A pay-for-performance program in Taiwan improved care for some diabetes patients, but doctors may have excluded sicker ones. Health affairs (Project Hope) 2012;31(1):93-102.
37. Liao HH, Lee WC, Chang WP, Wei HM. Implementing Tw-DRGs on diagnostic and therapeutic cardiac catheterization and impact on medical utilization. Journal of Healthcare Management 2014;15(2):111-127.

38. Karim SA, Pink GH, Reiter KL, Holmes GM, Jones CB. Et al. The effect of the magnet recognition signal on hospital financial performance. Journal of Healthcare Management 2018;63(6):e131-e146.
39. Bazzoli GJ, Fareed N, Waters TM. Hospital financial performance in the recent recession and implications for institutions that remain financially weak. Health Affairs 2014;33(5):739-745.
40. Barnes M, Oner N, Ray MN, Zengul FD. Exploring the association between quality and financial performance in US hospitals: A systematic review. Journal of Health Care Finance 2017;44(2):1-32.
41. Reiter KL, Jiang HJ, Wang J. Facing the recession: How did safety-net hospitals fare financially compared with their peers? Health Services Research 2014;49(6):1747-1766.
42. Dong GN. Performing well in financial management and quality of care. BMC Health Services Research 2015;15(1):45.
43. Liang YW, Chen WY, Lee JL, Huang LC. Nurse staffing, direct nursing care hours and patient mortality in Taiwan: The longitudinal analysis of hospital nurse staffing and patient outcome study. BMC Health Services Research 2012;12(1):1-8.
44. Schubert M, Clarke SP, Aiken LH, de Geest S. Associations between rationing of nursing care and inpatient mortality in Swiss hospitals. International Journal for Quality in Health Care 2012;24(3):230-238.
45. Butler M, Collins R, Drennan J, Halligan P, O'Mathuna DP, et al. Hospital nurse staffing models and patient and staff-related outcomes. Cochrane Database Systemic Review 2011;6(7).