

Hospital Partnership and Patient Outcomes Among Postacute Patients With Stroke

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Increased financial and managerial pressure to shorten the length of hospital stays raises serious concerns regarding the health of hospitalized patients. Early or premature discharge increases not only the risk of permanent disability and adverse outcomes but also economical and noneconomical burdens on families and society.¹ Programs such as postacute care (PAC) or intermediate care initiatives are widely adopted to enhance the continuity of postdischarge care. Studies have revealed that the proportion of discharges to PAC facilities (ie, skilled nursing home and rehabilitation facilities) increased nearly 50% over the past 15 years in the United States.^{2,3} In 2018, across England, Wales, and Northern Ireland, more than 650 intermediate care services providers, including crisis response teams, home-based intermediate care, bed-based intermediate care (ie, community hospitals and care homes), and reablement services, took part in the National Audit of Intermediate Care by the National Health Service.⁴ In Taiwan, the National Health Insurance (NHI) Administration launched a hospital-based stroke PAC initiative (NHI-PAC) in 2014 and expanded it in 2016. This pilot project aims to encourage higher-level hospitals to transfer inpatients to lower-level hospitals for PAC. Since 2016, more than 200 hospitals throughout Taiwan have participated and formed 38 multihospital PAC integrated systems.⁵ Some of these PAC initiatives have been reported to yield lower risks of readmissions, mortality, and other adverse outcomes.⁶⁻¹⁰ However, the large variations in outcomes for participants remain puzzling.¹¹⁻¹⁶

Health care providers form integration models with different aims.¹⁷ Some research has suggested positive impacts on efficiency and quality of care,¹⁸⁻²³ whereas other studies have indicated that integrated delivery models do not always yield the expected outcomes because of poor communication, lack of coordination, and improper transition.²⁴⁻²⁹ Because effective coordination requires interorganizational collaboration, provider partnership is believed to be a major building block of an efficient integrated care system. However, few studies have considered whether and the extent to which provider partnerships influence risks of adverse health events among patients being discharged to PAC facilities. Relevant studies have indicated that hospitals tend to discharge their patients to

ABSTRACT

OBJECTIVES: Postacute care (PAC) heavily relies on effective connection between acute and postacute providers. However, little is known about whether and to what extent providers' patient-sharing relationships influence patient outcomes. This study aimed to examine whether patients with stroke who were discharged to PAC hospitals with which the originating hospital had a strong patient-sharing relationship have a lower rate of rehospitalization and lower mortality risk.

STUDY DESIGN: This population-based retrospective cohort study used the Taiwan National Health Insurance Research Database. A total of 1988 patients initially hospitalized for stroke between July 1, 2017, and June 30, 2018, who were newly discharged to 193 PAC hospitals from 175 originating hospitals were included.

METHODS: We described the partnership between originating acute hospitals and PAC hospitals using tie strength and referral concentration. The main outcome included unplanned readmission and mortality. Hierarchical logistic regression analysis and Cox proportional hazards models were applied.

RESULTS: A dose-response relationship was clearly observed between tie strength and patient outcomes. Patients with stroke who were discharged to a PAC hospital that had the strongest tie strength with the originating hospital were least likely to be readmitted and had the lowest mortality risk. Moreover, patients who received care from hospital pairs with highly or moderately concentrated referrals also had lower readmission and mortality risk.

CONCLUSIONS: A greater number of shared patients and a more concentrated referral linkage between acute and PAC providers may reduce potential adverse outcomes in PAC patients. Instead of attaining more partners, PAC policies should encourage providers to strengthen their patient-sharing relationship with their existing PAC partners.

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TAKEAWAY POINTS

We found that joint care for patients with stroke by acute and postacute care (PAC) hospitals that share a stronger relationship was associated with more favorable postdischarge patient outcomes.

- ▶ A clear dose-response relationship between hospital partnership through shared patients and postdischarge adverse outcomes (ie, unplanned readmission and mortality) was observed among patients with stroke.
- ▶ A more concentrated referral linkage between acute and PAC hospitals may help to reduce potential adverse outcomes in PAC patients.
- ▶ These findings represent an opportunity for hospitals to improve outcomes among patients with stroke through more effective partnership strategies.

preferred skilled nursing facilities (SNFs) according to prior referral rates and patients' geographic proximity.³⁰ Most related studies have focused on comparing patient outcomes between those who were referred to PAC facilities within and outside of preferred networks. Patients who were referred to SNFs within the hospital's preferred provider networks had lower probability of readmission and medical costs.^{11,31} However, less is known regarding the nature of these partnerships and how partnerships influence patient outcomes. Because of the rising trend of integration in health care, the understanding of the relationship between provider partnership and patient outcomes has become a compelling research topic.³²⁻³⁷

Multiple data sources, such as survey data, case studies, and semistructured interviews, have been employed to assess organizational partnerships.^{30,38} However, studies relying on such primary data sources typically face challenges such as small sample size, low response rate, and lack of external validity. In a recent study, researchers assessed organization partnerships on the basis of shared patients among providers by using administrative data.¹⁹ Analyzing the properties of patient-sharing relationships may provide a unique perspective on provider partnerships in health care delivery.³⁹ When a patient is discharged from a hospital and admitted to another inpatient facility, information must be exchanged and coordinated among providers.⁴⁰ The assumption is that a large number of inpatients shared between hospitals increases opportunities for mutual learning, which could improve communication efficiency and effectiveness.^{39,41}

Few studies have investigated the association between the structure of the patient-sharing relationship and outcomes for inpatient care. A US study indicated that stronger hospital-SNF connections (the proportion of the hospital's discharges to an SNF) reduce rehospitalization rates.⁴¹ Other studies, in Italy, used regional administrative data to determine the hospital referral network by aggregating all interhospital acute transfers. One study found that the centrality of a hospital is positively related to its capability of providing health care services, which suggests that the general flow of ill patients is toward hospitals with high-quality resources⁴²; another study showed that hospital referral networks with greater network centrality (ie, higher concentration among a few prominent hospitals) and weaker ego-network density (ie, number

of connections) yield a lower readmission rate.⁴⁰

In summary, hospital partnership is critical to health care service delivery. However, few studies have employed administrative data to assess properties of hospital partnership on the basis of shared patients and to examine how patient-sharing relationships influence patient outcomes. More specifically, of the studies applying administrative data to assess hospital partnership and patient outcomes, few studies focused on inpatient care; those targeting inpatient care mostly focused on acute transfers. Because of the differences in

care complexity and provider types between acute and PAC transfer, assessing whether and how the patient-sharing relationship between acute and PAC providers influences patient outcomes may yield valuable insights. Furthermore, related studies are mostly limited to the Medicare population in the United States; the NHI-PAC program in Taiwan provides a unique opportunity to extend the research scope to a more general population under a single-payer system. Finally, research on PAC mostly compares outcomes between patients who did and did not participate in a PAC initiative, among various types of PAC facilities, or between PAC facilities that were or were not within a hospital's preferred provider network.^{3,6-9,11,14,31} This study aimed to extend relevant knowledge by exploring patient-sharing relationships between acute and PAC providers and how such relationships, including tie strength and the referral concentration, may influence patient outcomes among patients with stroke who had participated in the NHI-PAC program in Taiwan from July 1, 2017, to June 30, 2018.

METHODS

Data Sources

The main data source was the 2016-2018 NHI Research Database provided by the NHI Administration, Ministry of Health and Welfare. All the data sets were linked using scrambled identification numbers of individual beneficiaries and hospitals. The following data sets were accessed: Expenditures by Admissions and Details of Inpatient Order to obtain inpatient data for NHI beneficiaries, hospital characteristics, and mortality information; Registry for Beneficiaries to obtain patient characteristics, enrollment, and mortality information; and Registry for Catastrophic Illness Patients to obtain mortality information.

Study Population

This was a population-based retrospective cohort study. A 1-year lag was instituted between the exposures and outcomes to more accurately deduce temporal relationships. For the study sample, we identified patients who were first admitted to hospitals for stroke between July 1, 2017, and June 30, 2018, by using primary and secondary diagnosis codes (*International Classification of Diseases*,

Tenth Revision, Clinical Modification codes I60-I67, G45-G46). Only patients with stroke who participated in the NHI-PAC pilot project were included, so we can better ascertain that patient movement identified between hospitals in our study was through PAC referrals, not readmissions. Patients who were discharged to the PAC units of their admitting hospital were excluded. The final sample consisted of 1998 patients with stroke (Figure).

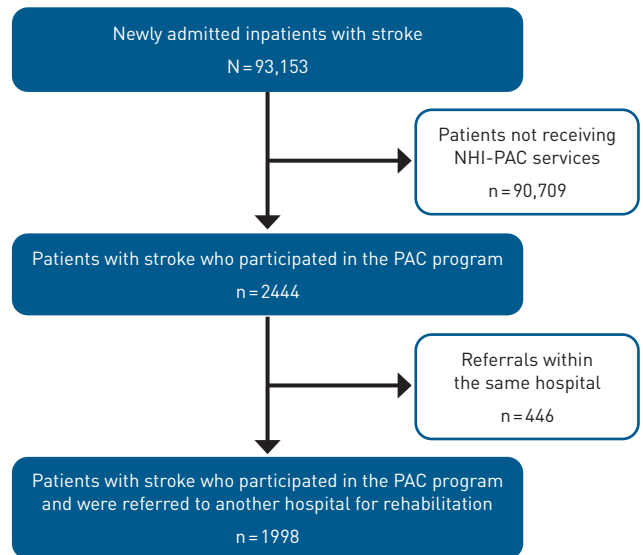
Study Variables

Independent variables. Provider partnership was assessed according to the patient-sharing relationship between acute and PAC hospitals based on their shared PAC referrals from July 1, 2016, to June 30, 2017. Patient sharing is commonly used to describe the connection among providers. Providers are defined as connected if they have cared for the same patient within a certain period. Because the NHI-PAC initiative adopts an inpatient-rehabilitation model, we defined partnership between an acute-PAC hospital pair by using 2 indicators: tie strength and referral concentration. Tie strength refers to the number of shared patients with stroke who were discharged from an acute hospital and later admitted to another hospital for PAC services within 30 days of their initial discharge. NHI payment codes (case type = 4) enabled us to identify the PAC referrals. Due to the highly skewed distribution of tie strength or referral concentration, the categorization of the 2 variables was used to avoid the occurrence of influential cases. According to the tie strength distribution of all hospital pairs, the hospital pairs' tie strength was classified into no shared patients, weak tie (below the top 50% strongest ties), and strong tie (at or above the top 50% strongest ties). Furthermore, to measure dispersion of referral in the hospital network, referral concentration was constructed. We calculated the number of PAC patients that a PAC hospital received from a specific acute hospital and divided that value by the total number of PAC patients that the same PAC hospital had. Similarly, according to the referral concentration distribution of all hospital pairs, hospital pairs were classified into no referral, low referral concentration (below the top 50% highest proportions), and high referral concentration (at or above the top 50% highest proportions).

Dependent variables. The main outcome variables were unplanned readmission (at 14, 30, 90, and 180 days) and mortality (at 30, 90, and 180 days) after the patient's discharge from the acute hospital. Some readmissions are required or planned, such as rehabilitation.⁴³⁻⁴⁵ This type of planned readmission is part of appropriate care and might lead to higher quality of care. Hence, we included only unplanned readmissions for analyses. Mortality was defined using the Registry for Catastrophic Illness Patients (death mark = Y), Expenditures by Admissions (tran code = 4, 9, and A), and Registry for Beneficiaries (status = 5) data sets. Either unplanned readmission or mortality was constructed as a binary outcome indicator.

Control variables. The characteristics of patients and hospital pairs were included as control variables. Patient characteristics included age, sex, socioeconomic status (insurable wage of < NT\$30,000, NT\$30,001-NT\$60,000, or > NT\$60,000, or no regular monthly

FIGURE. A Flowchart for Patients With Stroke in the PAC Program



NHI, National Health Insurance; PAC, postacute care.

wage), Charlson Comorbidity Index (CCI; no, mild, moderate, or severe), Stroke Severity Index (mild or moderate),⁴⁶ and residential divisions (Taipei, Northern, Central, Southern, Kao-Ping, or Eastern). Hospital-pair characteristics included accreditation level (downward referral, meaning referral from a higher-level acute hospital to a lower-level PAC hospital [ie, from medical center to regional or district hospital or from regional hospital to district hospital] or horizontal/upward referral, meaning referral from an acute hospital to a PAC hospital at the same level or higher level [ie, from regional hospital to another regional hospital, from district hospital to regional hospital, or from district hospital to another district hospital]), ownership status (public hospital or private hospital), and regional divisions.

Statistical Analysis

Descriptive statistics are presented as the total number (n) and percentage (%). For skewed data, medians and IQRs are presented. To determine the contribution of hospital-pair partnerships, both patient- and hospital-pair-level variables were included in the model. Backward selection was applied to identify the variables included in the final models. Because of the nested structure of the data, individual inpatients were nested within hospital pairs; 2-level hierarchical logistic regression analysis and Cox proportional hazards models were applied to explore the association of hospital relationship with unplanned readmission rate and mortality rate, respectively.

For sensitivity analyses, we employed alternative definitions for patient sharing by including the patients discharged to PAC units in the same hospitals; we also expanded the definition of patient

TABLE 1. Patient, Hospital, and Hospital-Pair Characteristics

Hospitalizations	n = 1988	%					
Age in years							
≤ 64	874	43.96					
65-74	531	26.71					
≥ 75	583	29.33					
Sex							
Male	1313	66.05					
Female	675	33.95					
Social-economic status by insurable wage per month							
< NT\$30,000	390	19.62					
NT\$30,000-NT\$60,000	449	22.59					
> NT\$60,000	143	7.19					
Other (without a regular monthly wage)	1006	50.60					
Comorbidity							
None	1346	67.71					
Mild	205	10.31					
Moderate	255	12.83					
Severe	182	9.15					
Stroke severity index							
Mild	1115	56.09					
Moderate	873	43.91					
Region							
Taipei	516	25.96					
Northern	318	16.00					
Central	375	18.86					
Southern	286	14.39					
Kao-Ping	439	22.08					
Eastern	54	2.72					
Hospital pairs	n = 702	%					
Accreditation level							
Downward referrals	413	58.83					
Horizontal or upward referrals	289	41.17					
Ownership							
Same ownership	401	57.13					
Different ownership	301	42.88					
Regional							
Same region	575	81.91					
Different region	127	18.09					
Patient-sharing metrics	Mean	SD	Min	Median	IQR	Max	
Tie strength	2.10	6.06	0	1	0-2	102	
Proportion of concentrating discharges from specific originating hospital	0.13	0.24	0	0	0-0.17	1.00	

TABLE 2. Patient Outcome Performance

Outcome	14 days	30 days	90 days	180 days
Unplanned readmission rate (%)	2.87	4.83	10.92	16.80
Mortality rate (%)	-	2.41	3.47	4.58

sharing beyond PAC referrals to include those who were admitted to hospitals for poststroke inpatient rehabilitation. Furthermore, for the partnership variables, we employed various categorizations to construct the tie strength and referral concentration variables (ie, trichotomize the tie strength or employ the 30% strongest ties according to the distribution of all the hospital pairs). Finally, instead of using all unplanned readmissions, we included only stroke-related unplanned readmissions. The results remained robust. All statistical analyses were performed using SAS version 9.4 and Enterprise Guide version 7.1 (SAS Institute Inc).

RESULTS

Description of Patients, Hospitals, and Hospital Pairs

Of the 1988 NHI-PAC referred inpatients identified from July 1, 2017, to June 30, 2018, more than half (56.04%) were 65 years or older (Table 1). The sample included more men (66.05%) and patients having no or mild comorbidity (78.02%). A total of 232 hospitals participated in the NHI-PAC program during the study period, forming 702 hospital pairs. Of the 232 hospitals, 175 referred patients with stroke to other hospitals for PAC and 193 received PAC patients with stroke; 58.83% of the hospital pairs resulted from downward PAC referrals, and the remaining 41.17% of the hospital pairs were horizontal or upward referrals. In the preceding year (ie, July 1, 2016, to June 30, 2017), the mean tie strength of these hospital pairs was 2.1, which means they had shared approximately 2 patients. Not all hospital pairs that shared PAC patients in the study year (ie, July 1, 2017, to June 30, 2018) had shared patients in the preceding year; therefore, 24.8% of hospital pairs had a tie strength of 0 because they did not share any patient in the preceding year. The PAC hospitals, on average, received approximately 13% of their PAC patients with stroke from 1 specific partner hospital.

Relationship Between Hospital Partnership and Patient Outcomes

Table 2 presents the unplanned readmission rate and mortality rate of the 1998 PAC patients with stroke. Table 3 reveals the association between hospital partnership and patient

TABLE 3. Association Between Hospital Partnership and Unplanned All-Cause Readmission and Mortality

	Unplanned all-cause readmission				Mortality		
	14 days	30 days	90 days	180 days	30 days	90 days	180 days
	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)	AHR (95% CI)	AHR (95% CI)	AHR (95% CI)
Tie strength							
No tie	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Weak tie	0.43 (0.03-7.14)	0.56 (0.29-1.08)	0.69 (0.43-1.10)	0.94 (0.65-1.37)	0.67 (0.31-1.47)	0.60 (0.31-1.18)	0.54 (0.29-1.00)*
Strong tie	0.24 (0.02-3.17)	0.49 (0.30- 0.82)**	0.63 (0.44-0.90)*	0.75 (0.56-1.00)*	0.29 (0.12-0.67)**	0.33 (0.16-0.65)**	0.35 (0.19-0.64)***
Proportion of concentrating discharges from specific originating hospital							
No referral	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Low concentration	0.23 (0.01-7.13)	0.45 (0.23-0.86)*	0.59 (0.38-0.93)*	0.81 (0.57-1.15)	0.75 (0.33-1.69)	0.62 (0.32-1.23)	0.58 (0.32-1.04)
High concentration	0.34 (0.03-3.63)	0.54 (0.33-0.89)*	0.67 (0.47-0.97)*	0.78 (0.58-1.05)	0.28 (0.12-0.66)**	0.33 (0.16-0.65)**	0.33 (0.18-0.59)***

AHR, adjusted HR; AOR, adjusted odds ratio; ref, reference.
P* < .05; *P* < .01; ****P* < .001.

outcomes. A clear pattern was observed: Stronger ties between acute-PAC hospital pairs resulted in lower likelihood of all-cause unplanned readmission. Patients who were sequentially cared for by acute-PAC hospital pairs with a strong tie were significantly less likely to be readmitted unexpectedly within 30 days (adjusted odds ratio [AOR], 0.49; 95% CI, 0.30-0.82), 90 days (AOR, 0.63; 95% CI, 0.44-0.90), and 180 days (AOR, 0.75; 95% CI, 0.56-1.00) of their acute discharge. In terms of mortality, a clear dose-response relationship was also observed for the relationship between tie strength and 30-, 90-, and 180-day mortality. Patients who were sequentially cared for by acute-PAC hospital pairs with a strong tie in the preceding year had the lowest 30-day (adjusted HR [AHR], 0.29; 95% CI, 0.12-0.67), 90-day (AHR, 0.33; 95% CI, 0.16-0.65), and 180-day (AHR, 0.35; 95% CI, 0.19-0.64) mortality risks, followed by those cared for by hospital pairs with a weak tie; the highest mortality risk was observed in patients cared for by acute-PAC hospital pairs without any shared patient in the preceding year.

In terms of PAC hospitals' level of concentrated patient sources, compared with those cared for by hospital pairs without any referral relationship, patients of hospital pairs with either a low level (30-day: AOR, 0.45; 95% CI, 0.23-0.86; 90-day: AOR, 0.59; 95% CI, 0.38-0.93) or a high level (30-day: AOR, 0.54; 95% CI, 0.33-0.89; 90-day: AOR, 0.67; 95% CI, 0.47-0.97) of referral relationship were significantly less likely to be readmitted unexpectedly. Similarly, if PAC hospitals received a high share of PAC patients with stroke from specific acute partner hospitals, patients of these hospitals had significantly lower mortality risks (30-day: AHR, 0.28; 95% CI, 0.12-0.66; 90-day: AHR, 0.33; 95% CI, 0.16-0.65; 180-day: AHR, 0.33; 95% CI, 0.18-0.59).

DISCUSSION

This is one of the first population-based studies to assess patient-sharing partnerships between acute and PAC hospitals and

investigate how such partnerships may influence outcomes in stroke patients. In this section, we highlight the major findings of this study.

First, consistent with previous studies,⁴⁰ we noted a clear dose-response relationship between hospital partnership through shared patients and postdischarge adverse outcomes (ie, unplanned readmission and mortality) among stroke patients. Frequent interactions through the sharing of patients are likely to increase hospitals' understanding of partners' capabilities, resources, and working routines, which can in turn assist hospitals in making the most appropriate referral decisions and lead to more favorable patient outcomes. More frequent interactions may also facilitate greater information sharing and communication among hospitals, which may help reduce errors during transition and follow-up care.

Second, we confirm the findings of a previous study in the United States regarding the importance of strong connections among hospitals.⁴¹ More importantly, not only concentrating discharges but also concentrating sources of PAC referral may lead to more favorable health outcomes among patients with stroke. PAC referrals involve the exchange of complex information and thus require high levels of communication and coordination among hospitals. Hence, receiving a high proportion of PAC patients from specific sources may reflect a higher commitment at senior levels of both organizations; it may also expedite information exchange on clinical and administrative practice patterns and increase interorganizational trust. Strengthened interaction, communication, and information exchange among care providers is critical to the successful rehabilitation and recuperation of stroke patients.

Finally, the NHI-PAC initiative has instituted organizational and financial incentives to enhance coordination between acute and PAC hospital partners since 2014. Nevertheless, approximately 20% of hospital pairs among the participating hospitals did not share PAC patients during the study period. The findings suggest

that between 2016 and 2018, most of the hospitals that participated in the PAC program did not have a strong tie with their partners, and they did not preferentially strengthen their partnership with specific partners. Thus, strengthening the partnerships among participating hospitals should be prioritized.

Limitations and Strengths

Some limitations in this study should be acknowledged. First, we used administrative data and patient sharing to determine the referral partnerships of hospitals. Although patient sharing has been validated in the literature as a measure of organizational partnership in health care, detailed mechanisms such as what and how information passes through the tie during patient sharing remain to be further explored. Second, factors driving patient selection of PAC hospitals may have led to selection bias. However, according to the clinical observations, patients and families tend to select a PAC hospital close to home. Also, because the study sample was only limited to patients with mild and moderate stroke severity and we adjusted for major patient characteristics, the influence of selection bias on the findings is unlikely to be substantial. Third, potential measurement errors of some clinical variables and the lack of some relevant variables are 2 major data limitations of the NHI Research Database. For example, because of data limitations, we could only adopt the Stroke Severity Index as a proxy of stroke severity; thus, misclassification bias may be possible. Fourth, because the participation rate of the NHI-PAC program during the study period was somewhat low (25%-30%), focusing only on patients with stroke in the NHI-PAC program may not fully reflect hospitals' overall PAC partnership activities. Fifth, due to data limitations, the study investigated only 2 medical outcomes, mortality and unplanned readmission. Future research with more data should extend the scope to more medical outcomes including recurrence, complication, and medical resource utilization variables such as mean length of stay and medical costs. Finally, our findings on patients with stroke may not be generalizable to other inpatient conditions.

To our knowledge, this was the first population-based study to assess hospital partnership and patient outcomes among PAC patients with stroke. One main strength of this study is to extend the research scope to PAC. In addition to number of patients shared between hospitals, referring concentration of a PAC hospital was also investigated. Another main strength of this study is generalizability. This study extends the existing literatures to the nonelderly population and to Asian health care systems.

CONCLUSIONS

This is the first population-based study examining the relationship between hospital partnership and outcomes among patients with stroke participating in the NHI-PAC program in Taiwan. Our findings indicate that patients with stroke who receive joint care from hospitals that share a stronger relationship, presumably through smoother care transition, experience more favorable postdischarge

outcomes. Patients in hospitals that receive a large proportion of their patients from specific partner hospitals had lower readmission and mortality rates. Instead of encouraging hospitals to attain more partners, PAC policies should encourage hospitals to deepen their patient-sharing relationships with a core group of PAC partners. ■

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