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Determinants of Patient Choice for Hospital Readmission after Township Hospitalisation: A Population-Based Retrospective Cohort Study in China

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Abstract

Objective: The lack of coordinated and appropriate healthcare across sectors has produced more patients for county hospitals. This research aimed to examine the differences in the choices between township and county hospitals for readmission after a township hospitalisation and the determinants that influence choice for hospital readmission.

Design: A retrospective cohort study drew out readmissions cross hospitals after first admission in township hospital, and the differences between township–township inpatients (TT group) and township-county inpatients (TC group) were compared. Moreover, a two-level logistic regression model was used to examine the determinants of choice for hospital readmission through MLwiN 2.30.

Setting: A population-based health utilisation database was used in Qianjiang District, China, from January 1, 2008 to December 31, 2013.

Participants: The study focused on readmitted individuals whose first admission was in township hospital. The readmission cases were identified with the same diagnosis in hospitalisation according to the ICD-10 within 30 days. In total, 6,764 readmissions had first admissions in township hospital.

Primary outcome measures: Patient choice for hospital readmission after township hospitalisation

Results: TT group accounted for 62.5% (4,225) and TC group accounted for 37.5% (2,539) in six years. These incidence rates varied in different towns ($P < 0.001$). The notable differences between TC and TT group characteristics are as follows: length of

stay (LOS) of first admission (6.96 versus 9.23), average interval (6.03 versus 14.95) and disease category. Admitting year, age, arrival time to county hospital, inpatient interval, LOS in first admission and disease category were the determinants of choice for hospital readmission.

Conclusions: Patients whose first admission was in a township hospital were more likely to be readmitted to a county hospital year by year. Reducing the incidence and decreasing patient dissatisfaction are the focused actions to rebuild the healthcare delivery system in rural China.

Keywords: readmission, choice, county hospital, patient flow, rural China

Article summary

• This is the first study to introduce township-county readmission, the unique form of hospitalisation in rural China.

• Population-level data on readmission is seldom reported across different level hospitals. A two-level logistic regression model was used for the consideration of aggregation at the town level.

• Findings in this research reveal the dissatisfied township-county readmission is a probable cause of inappropriate level of hospitalisation for the first time.

• The combination of first LOS and interval may be an effective identification index to identify the forms of township-county readmission.

• Hospitalisation information, geographical factor, referral status and disease were all drawn into the logistic regression model, but some individual factors were deficient.

Background

Readmission is an episode where an inpatient is readmitted for once disease with 30-day. [1, 2] In most studies, readmission findings reflect that inpatient care did not meet patient requirements, and readmission rate is used as an evaluation index of hospitalisation quality. [3] Readmission usually occurs in the same hospital, sometimes across hospitals because of the disease variability. [4] However, in rural China, multi-level institutional readmission is a popular and important healthcare utilisation, which reflects the defects of China's healthcare delivery system, instead of hospitalisation quality, especially township–county (TC) readmission. TC readmission is a health-seeking behaviour in which inpatients ask for healthcare services first in a township hospital and second in a county hospital, whether planned or unplanned, voluntarily or passively. TC readmission occurs constantly in rural China and accounts for approximately 4.0% of all inpatient services, currently. [5] It has become a common and inescapable healthcare utilisation. TC readmission usually occurs in two situations, namely, doctor suggestions and inappropriate individual choice. TC readmission as suggested by doctors occurs when a township doctor has an in-patient admission and finds that he/she cannot completely cure the patient or disease varied. [6] Consequently, the patient is referred directly to a county hospital or is advised to go to county hospitals for succeeding admission. This situation is caused by the fragmented healthcare delivery system in rural China, where residents seek care from a village–town–county three-tier healthcare delivery system, and all hospital services are supplied by township and county hospitals. [7] The higher the

level of the institution, the stronger the service capability, the longer the distance and the higher the medical cost. Town hospitals bear the responsibilities of transferring patients, taking care of inpatients with general illnesses and advising patients with severe diseases, which are beyond the capacity of township hospitals, to admit to county hospitals. [8] In particular, township doctors sometimes receive patients whose diseases are beyond their capacity because of their inaccurate judgment, or disease varied, and it is hard to avoid.

TC readmission caused by inappropriate individual choices happens when patients who should be readmitted to township hospitals choose to be admitted to county hospital for personal reasons. [9] Some readmissions are influenced by the quality problem of township hospitals, poor compliance on medicine and after-cure from patients themselves or a normal disease recurrence. Nonetheless, patients cannot recognise the accurate readmission reason and easily transfer the responsibility of readmission to the township doctor, thinking of it as failed treatment and consequently deciding to be readmitted to a county hospital. This situation is an inappropriate readmission.[10]

In the view of patients, no order or limitation on patient choice exists, and no GPs or consultants are available in rural China. Residents freely choose hospitals and service types, depending mainly on their judgment on the disease and the cognition on hospitals. If patients choose a higher institution than needed, they pay more; if they choose a lower institution than needed; they would be referred or readmitted. Thus, the cost of incorrect decision is borne by the patient himself. To guarantee patient

interests on TC readmission, the three-tier healthcare delivery system required different level hospitals to cooperate with one another in providing continuous healthcare services. In reality however, communications among township and county professional providers are limited, and no document sharing and interactions among providers across the three tiers are virtually present. [11] County doctors do not deliver continued care for readmitting patients on the account of income incentives and risk aversion, and patients readmitted to a county hospital usually get a new treatment. [12] Furthermore, compared with patients admitted directly to county hospitals, readmitting patients pay more time and costs and even miss the best kind of treatment. As a result, when diseases occur subsequently, and patients are unable to judge the severity of the disease, they would tend to choose the county hospital directly for admission, taking on excess economic risk to avoid delay. Some studies defined TC readmission as failed treatment in the view of patients and prove that TC readmission experience can influence the patient choice of hospitals afterwards.[13, 14] Gradually, inpatients will be more likely to gather in county hospitals compared with township hospitals; in fact, this kind of phenomenon is already happening. The annual growth rate of inpatients in county hospital is 6.75% whereas that of township hospital inpatients is 0.63% from 2010 to 2016.[15]

The first point of contact at primary medical institutions is the most efficient supply model, as proven by medical practices around the world. While TC readmission can easily result in inappropriate patient flow, patient admission to a higher-level hospital than necessary leads to significant waste. TC readmission has become a determinant

of increasing health expenditure. [13] Chinese government is seeking to solidify the fragmented three-tier healthcare delivery system through the first point of care in primary institutions and collaboration between township and county hospitals. Given the current situation, guiding patients to choose the correct hospital for readmission has rationally been a necessary consideration and a key content, and thus, the identification of the choice for hospital readmission could be the first step. This research focuses particularly on the choices for hospital readmissions, considering that the first admission of an inpatient was in a township hospital, and makes clear determinants of choice for hospital readmission.

Methods

Study setting

We focused on individuals who had been discharged from participant hospitals. The readmission cases were identified as the same diagnosis in hospitalisation between county and township hospitals within 30 days. From a design of population-based retrospective cohort, we compared the difference between township–township readmitted inpatients (TT group) and TC readmitted inpatients (TC group).

Data source

Qianjiang District was designated as the sample area through cluster sampling. It is a typical rural area located in Chongqing and is the largest municipality in southwest China. Qianjiang has a per capita GDP of 3984$, which is below the average GDP in China. The resident population is 550 thousand, and all residents are covered under

the New Rural Cooperative Medical System (NRCMS), where all residents could receive reimbursement for inpatient care. Two county hospitals and 30 township hospitals are in Qiangjiang District, and all township hospitals were divided into four levels according to their scale and service quantity (Fig. 1). This study was based on the NRCMS inpatient database in Qianjiang District, which contains all inpatient utilisation of all population. In this database, a case means a single hospitalisation, county or township hospitalisation.

Data processing

This retrospective cohort study drew out all readmissions whose first inpatient admission was in a township hospital. Samples were selected by MS Excel 2010 based on the NRCMS database from January 1, 2008 to December 31, 2013. First, cases that shared the same patient identifier and the same disease codes were sorted together in a chronological order. Second, we calculated the time interval in every adjacent two cases of the same inpatient for the same disease; if the interval time was less than 31 days, then the patient would be marked as a readmission patient. Then, if the former inpatient of the readmission occurred in a township hospital, and the later occurred in county hospital, the two cases would be merged as one case and is marked as a TC readmission, and the patient would be marked as TC patient. TT and TT patients were treated in the same way. Finally, all TC and TT cases were extracted into a new database. Complementally, the diagnosis of the same disease may change among different doctors, in different institutions or at different time; thus, we adjusted the original ICD-10 disease code to a broader code (taking chronic obstructive

pulmonary disease for example, and its disease code was adjusted from J44.900 to J44), which may improve accuracy of readmitting patients. After screening, the number of readmitting patients in the sample county was 6,764 from 2008 to 2013. Sociological characteristics, such as gender, age, arrival time to county hospital, first inpatient information including length of stay (LOS), expenses, disease category, capacity of the township hospital, interval information and readmitted hospital choice,[16] were collected to build a final database. The distance and arrival time to county hospital of all readmitting patients were captured by Google Map individually. This study was registered in the Chinese Clinical Trial Registry (ChiCTR-OOR-14005563), and patient information was anonymised and de-identified prior to analysis.

Statistical analysis

Both treatment capacity of township hospital and arrival time to county hospital were could be the influencing factors of choice for hospital readmission. The obtained data indicated a hierarchical structure, and the 6,764 records may be aggregated by town level. The determinants of choice for hospital readmission were examined using multilevel binomial logistic regression analysis by MLwiN 2.30, which was developed by the University of Bristol, UK. [17] The regression model is as follows.

$$\begin{aligned}\log it(\pi_{ij}) = {} & \beta_{0j}\text{cons} + \beta_1\text{Admitted Year}_{ij} + \beta_2\text{Gender}_{ij} + \beta_3\text{Age}_{ij} + \beta_4\text{Distance}_{ij} + \beta_5\text{Time}_{ij} \\ & + \beta_6\text{Capacity}_{ij} + \beta_7 1^{st}\text{LOS}_{ij} + \beta_8 1^{st}\text{Expends}_{ij} + \beta_9\text{Interval}_{ij} + \text{More14}_{ij}\end{aligned} \quad (193)$$

$$\beta_{0j} = \beta_0 + u_{0j} \quad (194)$$

β_i refers to the fixed effects parameter, u_{oj} refers to the random effects of level 2.

Results

Choices for hospital readmission after township hospitalisation

In 2008–2013, 6,764 first readmissions in township hospital occurred among 271,405 discharged admissions, where TT group accounted for 62.5% (4,225) and TC group accounted for 37.5% (2,539), as shown in Table 1.The number of readmissions increased sharply, whereas the proportion of readmissions in the total inpatients changed a little, nearly 5.0%. TC group increased from 1.66% to 1.89% from 2008 to 2013.

Table 1. Amounts of readmissions in each year, Qianjiang district, 2008–2013

Year	All inpatients	Readmissions* n (%)**	Choice for hospital readmission**		*P*
			TT group n (%)	**TC group** n (%)	
2008	21,823	524 (4.8)	342 (3.13)	182 (1.66)	<0.001
2009	34,240	1,076 (6.29)	724 (4.03)	352 (2.05)	
2010	35,866	942 (5.25)	608 (3.39)	334 (1.86)	
2011	50,616	1,260 (4.98)	797 (3.14)	463 (1.82)	
2012	61,467	1,384 (4.5)	815 (2.56)	569 (1.85)	
2013	67,392	1,578 (4.68)	939 (2.78)	639 (1.89)	
Total	271,405	6,764 (4.98)	4225 (3.11)	2539 (1.87)	

*Readmission here refers to readmission whose first admission was in a township hospital.

**One readmission includes two admissions.

Readmission occurred variedly in different towns, as shown in Table 2. Chengnan town had the lowest readmission ratio (2.95%) and the lowest TT readmission ratio (1.52%) in 30 towns, Heixi town had the lowest TC readmission ratio (1.30%), Shijia town had the highest TC readmission ratio (2.86%) and Jindong town had the highest TT readmission ratio (5.49%) and readmission ratio (6.96%).

Table 2. Amounts of readmissions in each town, Qianjiang district, 2008–2013

Town	All inpatients	Readmissions* n (%)**	Choice for hospital readmission**		*P*
			TT group n (%)	**TC group** n (%)	

Chengnan	11,716	173 (2.95)	89 (1.52)	84 (1.43)	
Heixi	9,073	137 (3.02)	78 (1.72)	53 (1.30)	
Shaba	8,778	152 (3.46)	81 (1.58)	71 (1.62)	
~	~	~	~	~	<0.001
Shijia	8,605	223 (5.18)	100 (2.32)	123 (2.86)	
~	~	~	~	~	
Jindong	6,007	209 (6.96)	165 (5.49)	44 (1.46)	
Total	271,405	6,764 (4.98)	4225 (3.11)	2539 (1.87)	

* Readmission here refers to readmission whose first admission was in a township hospital.

**One readmission includes two admissions.

Characteristics of readmitting patients between TT and TC groups

Table 3 shows the characteristics of the subject patients during 2008–2013. Male patients accounted for 48.7% in TC group, higher than that in the TT group (41.9%, $P < 0.001$). The readmission choices varied in different age groups ($P< 0.001$), and patients aged more than 40 years old in TC group reached than a half (57.9%). The highest rate of TC group in inpatient interval was fewer than 3 days (61.1%) and that of TT group was 16–30 days (50.6%, $P < 0.001$). The average interval in TC group is much lower than that in TT group (6.03 versus 14.95), the same result was showed in terms of average LOS in first inpatient admission (6.96 versus 9.23) and arrival time to county hospital (59.73 versus 61.79); the opposite results were observed in terms of expenses in first inpatient admission (￥831.35 versus ￥791.01). TC group mostly had respiratory diseases (37.7%) and digestive diseases (20.3%). No significant differences among the distance to county hospital, and township hospital capacity were observed between TT and TC groups.

Table 3. Distributions of characteristics of readmissions (n = 6,764)

Variable	All n (%)	Choice for hospital readmission		*P*
		TT group n (%)	TC group n (%)	

All	6,764	4,225 (62.5)	2539(37.5)	
Gender				<0.001
Male	3,006 (44.4)	1769(41.9)	1237(48.7)	
Female	3,758(55.6)	2456(58.1)	1302(51.3)	
Age, years				
Mean (SD)	48.18 (0.27)	46.94(0.35)	50.25(0.43)	<0.001
Less than 20	950 (22.0)	629(22.9)	321(20.5)	<0.001
20–39	1,215 (28.2)	877(31.9)	338(21.6)	
40–59	2,045 (47.4)	1192(43.4)	853(54.4)	
More than 59	103 (2.4)	48(1.7)	55(3.5)	
Distance to CH (km)				
Mean (SD)	36.29 (0.27)	35.99(0.34)	36.78(0.42)	0.15
Time to CH (min)				
Mean (SD)	60.51 (0.45)	59.73(0.57)	61.79(0.72)	0.03
Capacity of TH		0.53		0.53
1st level (Strong)	3,076 (45.5)	1918(45.4)	1158(45.6)	
2nd level (Better)	1,315 (19.4)	802(19)	513(20.2)	
3rd level (General)	9,35 (13.8)	591(14)	344(13.5)	
4th level (Weak)	1,438 (21.3)	914(21.6)	524(20.6)	
1st LOS (day)				
Mean (SD))	8.38 (0.12)	9.23(0.16)	6.96(0.16)	<0.001
1st Expense (RMB)				
Mean (SD)	816.21 (7.94)	831.35(9.95)	791.01(13.14)	0.01
2nd LOS (day)				
Mean (SD)	10.24 (0.13)	10.03(0.16)	10.58(0.22)	0.04
2nd Expense (RMB)				
Mean (SD)	2215.49 (45.46)	862.99(12.77)	4466.09(104.99)	<0.001
Interval (day)				
Mean (SD)	11.6 (0.12)	14.95(0.14)	6.03(0.17)	<0.001
~3	2,133(31.5)	582(13.8)	1551(61.1)	<0.001
3–7	761 (11.3)	517(12.2)	244(9.6)	
7–15	1,328 (19.6)	987(23.4)	341(13.4)	
16–31	2,542 (37.6)	2139(50.6)	403(15.9)	
Disease category				
Cancer	178 (2.6)	109(2.6)	69(2.7)	<0.001
ENT disease	338 (5.0)	243(5.8)	95(3.7)	
Respiratory disease	2,673 (39.5)	1715(40.6)	958(37.7)	
Circulatory disease	450 (6.7)	224(5.3)	226(8.9)	

Digestive disease	984 (14.5)	469(11.1)	515(20.3)
Urinary disease	269 (4.0)	89(2.1)	180(7.1)
Haematological disorders	19 (0.2)	2(0.1)	17(0.7)
Bones and muscles	425 (6.3)	218(5.2)	207(8.2)
Obstetrics and gynaecology	1,213 (17.9)	1037(24.5)	176(6.9)

Determinants of choice for hospital readmission after township hospitalisation

The two-level logistic regression used and the patients were identified as level 1 and town as level 2. The results are illustrated by the level 2 variance of the zero model, which was statistically significant (χ^2=61.493, P<0.001), with aggregation of information at the town.

The specific results of the explanatory variables to fit two variance component models are shown in Table 4. The major determinants of the choice for hospital readmission after township hospitalisation were admitted year, age, arrival time to county hospital, inpatient interval, first LOS and disease category. If other factors remain constant, then patients were more likely to be readmitted to county hospital among aged more than 40-year-old groups (*OR*=1.31), with shorter time to county hospital, shorter LOS, shorter interval, with urinary tract diseases (*OR*=2.67) or in the closer year. The ratio of patients with obstetrics or gynaecology diseases readmitted to county hospital is much lower than that of patient with cancer (*OR*=0.39).

Table 4 Multilevel logistic regression model analysis of the choice for hospital readmission

	Parameter estimate	Standard error	χ^2	*P*	Adjusted OR
Fixed Part:					
Constant	−269.7	39.130	47.513	<0.001	—
Admitted Year	0.135	0.019	47.825	<0.001	1.14
Gender(baseline: female)					1.00
Male	−0.003	0.065	0.003	0.956	1.00

Age (baseline: less than 20)					1.00
20–39	−0.061	0.122	0.249	0.618	0.94
40–59	0.271	0.104	6.760	0.009	1.31
More than 59	0.034	0.101	0.115	0.735	1.03
Distance (km)	0.012	0.004	10.725	0.052	1.01
Time (min)	−0.021	0.006	11.841	<0.001	0.98
Capacity of TH	−0.016	0.035	0.197	0.657	0.98
1st LOS (day)	−0.036	0.005	53.167	<0.001	0.96
1st Expends (RMB)	0.001	0.001	1.304	0.254	1.00
2nd LOS (day)	−0.002	0.003	0.214	0.644	0.99
Interval (day)	−0.110	0.004	895.43	<0.001	0.90
Disease category (Baseline: cancer)					1.00
ENT	−0.405	0.261	2.401	0.121	0.67
Respiratory disease	−0.250	0.217	1.326	0.250	0.78
Circulatory disease	0.515	0.240	4.619	0.032	1.67
Digestive disease	0.556	0.226	6.077	0.014	1.74
Urinary disease	0.981	0.263	13.938	<0.001	2.67
Haematological disorders	2.305	0.847	7.408	0.006	10.02
Bones and muscles	0.245	0.239	1.055	0.304	1.28
Obstetrics and gynaecology	−0.946	0.238	15.847	<0.001	0.39
Else	−0.132	0.264	0.250	0.617	0.88
Random Part:					
TH variance	0.152	0.036	17.811	<0.001	—
Patient scale parameter	1	0.00	—	—	—

Note: Capacity of township hospital is included in the analysis by order of ranked data.

Discussion

Choice for hospital readmission and aggregation

Readmission is common and inescapable, and can be attributed to technology and management problems. [18] TC readmission accounts for 1.87% of all hospitalisation cases in Qianjiang, and one third of the readmission cases had first inpatient admission was in a township hospital, which is indeed a popular utilisation in rural

China. However, as mentioned TC readmission, either through doctor suggestions or patient choice, is an inefficient utilisation, TC patients suffer from disease delays or cost waste, easily causing patient dissatisfaction on township hospital. One point that needs to be explained here is the uncertainty as to whether TT patients has also been readmitted to a county hospital thrice or more, which does exists in a real scenario. The two-level logistic regression showed an evident hierarchy among the inpatient data (town–patients). Patients' choice for hospital readmission in the town level were clustered. In other words, 6,764 readmitting patients were non-independent, and the choices for hospital readmission in same town tend to be approximated. The incidence differed from 2.95% (Chengnan) to 6.96% (Jindong) in different towns, the 30 towns differed in township hospital, social customs and geographic location, and different township hospitals carried out different service concepts and medical capabilities, which affected patient's choice for hospital readmission.

Determinants of the choice for hospital readmission

Logistic regression analysis showed that neither patient gender, capacity of township hospital nor first expenses had any significant effects on the choice for hospital readmission, which was affected by age, arrival time to county hospital, inpatient interval, LOS in first inpatient and disease category. Although the towns that patients lived in affected their choice for hospital readmission, capacity of township hospital had no significant effects, so the town effects could be speculatively attributed from social customs and geographic location, same results with Calvillo King.[19] In other words, regardless of capacity of township hospital, readmission is inescapable under

the same OR, and prevalence was produced from the doctors' assessment on treatment ability, or disease varied not the general capacity in theory.[20]

In general, patients were more likely to be readmitted to a county hospital among groups of older age, more convenient, lower expense, shorter interval or diseases those were harder to assess, easier to vary. With the increase of age, the ratio of choosing to be readmitted to a county hospital also increased, which may be caused by the increased attention on the cure rate among those with more advanced ages. The OR in terms of arrival time to county hospital is 0.98, which is easy to understand that patients pursue a convenience choice.[16, 19] The most obvious influencing factors are first LOS and the interval, and we need to combine them to discuss the difference in choice. The average first LOS of TT groups is 9.23 days, which is very close to 9.7 days, the standard LOS in township hospitals in China, moreover, the average interval was 14.95 days, and the same ratios in TC groups were 6.96 and 6.03 days. The shorter the first LOS (*OR*=0.96), with shorter interval (*OR*=0.90), the higher the ratio of choosing county hospital. This disparity would be associated with the degree of emergency of disease. For types of diseases, patients with diseases related to the urinary systems (*OR*=2.67) and haematological disorders (*OR*=10.02) were more likely to choose county hospital compared with those with cancer, respiratory diseases and other disease types. This finding can be related to township doctor assessment on treatment ability. Diseases in the urinary system, cardiovascular system and haematological disorders cannot be controlled well in township hospitals, and thus, a higher rate of inaccurate assessments, higher probability of readmission to county

hospital. [21] Respiratory and digestive diseases, such as influenza, paediatric bronchial pneumonia and COPD, [22] have a high incidence and recurrence rate and can be controlled in township hospital. Meanwhile, these diseases usually have failed treatment outcomes because of poor patient compliance on medicine and after-cure.[23] Consequently, these patients more choose township hospitals for their readmission. Moreover, the readmissions tend to county hospitals as time draws near (*OR*=1.14), which implies an endogenous factor affects the increase of inpatients in county hospitals in recent years.

Amendments of TC readmission

According to the results, we could identify the forms of TC readmission by the first LOS and interval in preliminary. Intervals in TC patient admission show a 'U'-shaped distribution; 61.1% was readmitted to a county hospital within 3 days, and a small prevalence peak appeared in the group after more than 15 days. Correspondently, 50.1% of the patients in TT patients were in the group more than 15 days. Thus, the shorter the first LOS and the shorter the interval, the higher the probability of TC readmission as suggested by doctors. Longer first LOS and longer interval are more likely to conversely cause an inappropriate level of care of readmission. Therefore, the combination of first LOS and interval may be an effective identification index, and we took one week as the cut-off value as illustrated from Table 3. TC readmissions caused by doctor incorrect assessment was approximately 70.7%, and those caused by patients probably accounted for 29.3%. So, we can develop different interventions based on the different types of TC readmission.

Dealing with the bad influence of TC readmission become a key content of China's new healthcare reform, which involves rebuilding the tiered healthcare delivery system. The negative effects of TC readmission can be decreased in two steps. First, the incidence of TC readmission was reduced, which is inescapable but abasable. [24] The key is to improve the diagnosis of township doctors and antidiastole level, for example, by establishing a clear diagnosis protocol to common diseases for township hospitals, or risk prediction models for hospital readmission.[25] Second, decreasing TC patient dissatisfaction is necessary, such as approval and the use of treatments from township hospital, county doctors deliver continued care for admitting patients. Chinese government should explore a new mechanism to stimulate doctors to supply continued care between township and county hospitals, such as global budget of multi-level institutions on certain diseases. Continued care could save examinations and decrease inpatient cost, then increase patient satisfaction. When a patient gets sick and needs hospitalisation, he or she would be willing to choose township hospital again.

Conclusions

Inpatients were more likely to choose county hospital for readmission year by year. Moreover, TC readmission remains a popular utilisation in rural China and easily produces inappropriate patient flows. Differences in readmission choices were associated with age, arrival time to county hospital, first LOS, interval and diseases, which are all easy to be identified. Reducing the incidence of TC readmission and decreasing patient dissatisfaction are the focused actions to restore the network

function of three-tier healthcare delivery system in rural China.

However, our study has several limitations. Hospitalisation information, geographical factor, referral status and disease were all drawn into the logistic regression model in this study, but possible individual factors, such as economic capability, education and preference, were deficient. Moreover, the influence on choice of hospitals may be an accumulated process, which means the more patients experience TC, the more significant the influence would become. However, we only studied the influence of the first TC in a year. All these limitations may bring instability to our study and need to be solved in further studies.

Competing interests

The authors have declared that no competing interests exist.

Authors' contributions

Y.Z. and L.Z. participated in conception and design, and the analyses, and wrote the manuscript. Y-D.N. participated in data collection and performed the statistical analysis. L.Z. helped to draft the manuscript, reviewed the manuscript and made final changes. All authors have given their final approval of the version to be published.

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Figure Legend

Figure 1. Map of Qianjiang distract: geographic distribution

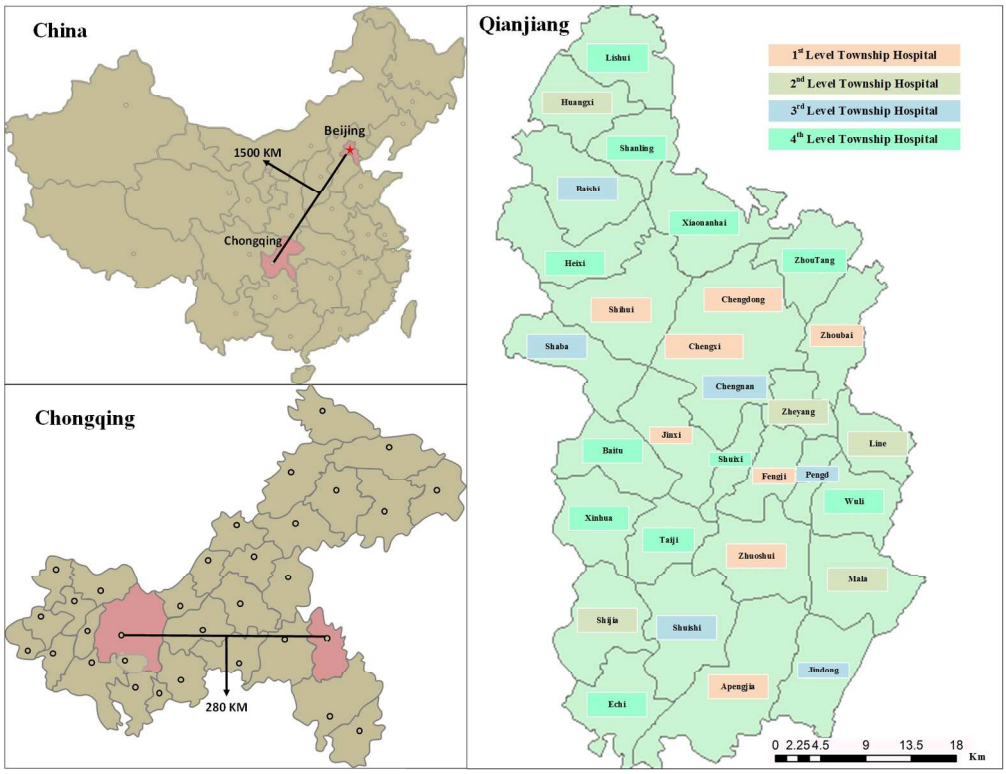

Figure 1. Map of Qianjiang distract: geographic distribution

399x308mm (120 x 120 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	**1**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	**2-4**
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	**4-7**
Objectives	3	State specific objectives, including any prespecified hypotheses	**7**
Methods			
Study design	4	Present key elements of study design early in the paper	**7**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	**7**
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	**8**
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	**9**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	**8**
Bias	9	Describe any efforts to address potential sources of bias	**N**
Study size	10	Explain how the study size was arrived at	**9**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	**7**
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	**10**
		(*b*) Describe any methods used to examine subgroups and interactions	**10**
		(*c*) Explain how missing data were addressed	**N**
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	**N**
		(*e*) Describe any sensitivity analyses	**N**
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	**9**
		(b) Give reasons for non-participation at each stage	**N**
		(c) Consider use of a flow diagram	**N**
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	**10**
		(b) Indicate number of participants with missing data for each variable of interest	**N**
Outcome data	15*	Report numbers of outcome events or summary measures	**9**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	**13-15**
		(*b*) Report category boundaries when continuous variables were categorized	**13-15**
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	**13-15**
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	**10-13**
Discussion			
Key results	18	Summarise key results with reference to study objectives	**13-17**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	**19**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	**17-19**
Generalisability	21	Discuss the generalisability (external validity) of the study results	**19**
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	**21**

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Determinants of Patient Choice for Hospital Readmission after Township Hospitalisation: A Population-Based Retrospective Study in China

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Determinants of Patient Choice for Hospital Readmission after Township Hospitalisation: A Population-Based Retrospective Study in China

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Abstract

Objective: The lack of coordinated and appropriate healthcare across sectors has produced more patients for county hospitals in China. This study examined differences in patient choice between township and county hospitals for readmission after a first township hospitalisation, and the determinants that influenced this choice.

Design: A retrospective study of readmissions across hospitals after a first admission in township hospital. A township–township inpatient (TT) group and a township–county inpatient (TC) group were compared. A two-level logistic regression model was used to examine the determinants of choice for hospital readmission.

Setting: Data were drawn from a population-based health utilisation database for Qianjiang District, China, from 1 January 2008 to 31 December 2013.

Participants: This study focused on readmitted patients whose first admission was in a township hospital. Readmission cases were identified as the same diagnosis (International Classification of Diseases, tenth revision) in a subsequent hospitalisation within 30 days. In total, 6,764 readmissions had first admissions in township hospitals.

Primary outcome measures: Patient choice for hospital readmission after a first township hospitalisation

Results: The TT group accounted for 62.5% (4,225) and the TC group for 37.5% (2,539) of readmissions in 6 years. Readmission rates varied among towns ($P < 0.001$). Differences between the TC and TT groups included: length of stay (LOS) of first admission (6.96 days vs. 9.23 days), average interval between admissions (6.03 days vs. 14.95 days) and disease category. Admission year, age, travel time to county hospital, interval between admissions,

first admission LOS and disease category were determinants of choice for hospital readmission.

Conclusions: Patients whose first admission was in a township hospital were more likely to be readmitted to a county hospital. A combination of first LOS and interval between admissions may be an effective identification index for township–county readmission.

Keywords: readmission, choice, county hospital, patient flow, rural China

Strengths and limitations

- This is the first study to introduce township-county readmission, a feature of hospitalisation in rural China.
- Population-level data on readmission is seldom reported across hospitals of different levels.
- Programming techniques, including Microsoft Excel formulas and case processing technologies, were used in the data processing.
- A two-level logistic regression model was used to consider aggregation at the town level.
- Hospitalisation information, geographical factors, interval status and disease were all entered into the logistic regression model, but some individual factors were missing.

Background

Readmission refers to an episode where an inpatient is readmitted for the same disease with 30 days.[1, 2] In most studies, readmission findings reflect that inpatient care did not meet patient requirements, with readmission rates used as an evaluation index for hospitalisation quality.[3] Readmission usually occurs in the same hospital, but sometimes

occurs across hospitals because of deterioration of a patient's disease.[4] However, in rural China, multilevel institutional readmission is a common and important healthcare utilisation. This reflects defects of China's healthcare delivery system, rather than hospitalisation quality, especially in township–county (TC) readmissions. TC readmission is a health-seeking behaviour in which inpatients seek healthcare services in a township hospital first, and then in a county hospital, whether planned or unplanned, voluntarily or passively. TC readmission is frequent in rural China, and currently accounts for approximately 2.0% of all inpatient services.[5] TC readmission usually occurs following doctor recommendation/referral or by individual patient choice.

TC readmission recommended by doctors occurs when a township doctor has an inpatient admission that they cannot fully treat or completely cure;[6] consequently, that patient is referred directly to a county hospital or advised to go to a county hospital for subsequent admission.[6] This situation results from the three-tier healthcare delivery system in rural China, where care is provided in a village–town–county healthcare delivery system, and all hospital services are supplied by township and county hospitals.[7] In general, the higher the level of the institution, the stronger the service capability, the greater the distance a patient must travel and the higher the medical cost. Township hospitals bear the responsibilities of transferring patients, taking care of inpatients with general illnesses and advising patients with severe diseases (that are beyond their capacity) to seek admission at county hospitals.[8] Township hospital doctors sometimes receive patients whose diseases are beyond their capacity to manage (e.g. because of their inaccurate judgment, or deterioration of the disease), meaning TC readmission may be unavoidable.

TC readmission from individual choice occurs when patients who should be readmitted to township hospitals choose to be admitted to county hospitals for personal reasons.[9] Some readmissions are influenced by quality concerns with township hospitals, poor patient compliance on medicine and after-care or from a normal disease recurrence. However, patients often do not acknowledge the real readmission reason and transfer responsibility for readmission to the township hospital doctor (e.g. considering readmission as a result of failed treatment) and consequently decide to be readmitted to a county hospital. This situation often represents inappropriate readmission.[10]

From the patients' perspective, no order or limitation on patient choice exists. In addition, no general practitioners or consultants are available in rural China. Therefore, residents freely choose hospitals and service types, mainly depending on their judgment regarding their disease and understanding of hospitals. If a patient chooses a higher-level institution than necessary, they pay more; if they choose a lower-level institution than necessary they would be referred or readmitted. Therefore, the cost of an incorrect decision is borne by the patient. To guarantee patient interests regarding TC readmission, the three-tier healthcare delivery system requires different-level hospitals to cooperate in providing continuous healthcare services. However, in reality, communication among township and county professional providers are limited, and there is virtually no document sharing and interactions among providers across the three tiers.[11] County hospital doctors do not deliver continued care for readmitted patients because of income incentives and risk aversion, and patients readmitted to a county hospital usually receive new treatment.[12] Furthermore, compared with patients admitted directly to county hospitals, readmitted

patients spend more time, pay more costs and may even miss proper treatments. As a result, when subsequent illnesses occur and patients are unable to judge the severity of their illness, they tend to choose admission in a county hospital, taking excess economic risk to avoid delay. Some studies have defined TC readmission as failed treatment from the patients' perspective, and shown that the TC readmission experience can influence a patient's later choice of hospital.[13, 14] Inpatients may be more likely to seek care in county hospitals compared with township hospitals; a phenomenon that is already happening. The annual growth rate of inpatients in county hospitals from 2010 to 2016 was 6.75%, whereas that of township hospital inpatients was 0.63%.[15]

As noted, TC readmission from individual choice belongs to the inappropriate level admission, and TC readmission recommended by doctors can also result in inappropriate level admission for subsequent hospitalisation. Inappropriate level admission means patients seek healthcare in a higher-level hospital than necessary. This may result from patients' intentional institution selection and distrust of the capability of township hospitals; such patients prefer to spend more money on healthcare to avoid the risk of needing referral. Inappropriate level admission is a major form of excess service demand,[12] and an important determinant of increasing health expenditure that leads to significant waste. In this context, identifying the forms and determinants of TC readmission will help to improve the New Rural Cooperative Medical System (NRCMS). This study focused on choices for hospital readmission after a first admission as an inpatient in a township hospital, and identified the determinants of choice for hospital readmission.

Methods

Study setting

Qianjiang District was designated as the sample area through cluster sampling. This is a typical rural area located in Chongqing, which is the largest municipality in southwest China. Qianjiang has a per capita GDP of $7,515 in 2016, which is below the average GDP in China. The resident population is 550,000 people; all residents are covered under the NRCMS, and are eligible to receive reimbursement for inpatient care. Qiangjiang District has two county hospitals and 30 township hospitals. The township hospitals are divided into four levels according to their scale and service quantity by Qianjiang Health Bureau (Fig. 1). First-level township hospitals are allocated more than 30 beds and may perform abdomen operations; these hospitals had more than 1,200 discharged patients in 2013. Second-level township hospitals cannot perform abdomen operations of the same scale. Third-level township hospitals have fewer than 30 beds and around 600~1,200 discharged patients. All other township hospitals belong to the fourth level.

Data source

This study was based on the NRCMS inpatient database in Qianjiang District, which contains all inpatient data for the population. In this database, a case refers to a single hospitalisation in a county or township hospital.

Data processing

We focused on individuals who had been discharged from participating hospitals.

Readmission cases were identified as the same diagnosis in subsequent hospitalisations between county and township hospitals or township hospitals and township hospitals within 30 days. Given our population-based retrospective design, we compared the differences between township–township readmitted inpatients (TT group) and TC readmitted inpatients (TC group). Samples were entered into MS Excel 2010, based on the NRCMS database from 1 January 2008 to 31 December 2013. First, cases that shared the same patient identifier and the same disease codes were sorted in chronological order. Second, we calculated the interval between admissions in two adjacent cases for the same inpatient for the same disease; if the interval between admissions was less than 31 days, the patient was marked as a readmission patient. For example, if the first admission occurred in a township hospital and the second occurred in county hospital, the two cases would be merged as one case and marked as a TC readmission, and the patient marked as TC patient. TT patients were identified in a similar manner. Finally, all TC and TT cases were extracted into a new database. As diagnosis of a disease may change among different doctors, in different institutions or at different times, we adjusted the original International Classification of Diseases, tenth revision disease code into a broader code (e.g. chronic obstructive pulmonary disease was adjusted from J44.900 to J44), which may improve accuracy in identifying readmitted patients. After screening, there were 6,764 readmitted patients from 2008–2013 in the sample. The main programming techniques included Microsoft Excel formulas (e.g. COUNTIF, SUMPRODUCT, LOOKUP and IF) and case processing technologies (e.g. split columns and removal of duplicates).

Sociological characteristics were collected to build a final database, including: gender; age;

travel time to county hospital; first inpatient information including length of stay (LOS), expenses, disease category, capacity of the township hospital, interval between admissions and readmitted hospital choice.[16] The distance and travel time to the county hospital for all readmitted patients were captured individually by Google Maps. Because traffic conditions are different in different towns (e.g. national roads, provincial roads or county roads), both the distance and travel time were captured.

Statistical analysis

The characteristics of patients' choices for hospital readmission were compared using t-tests and chi-square tests in IBM SPSS Statistics 22.0. The treatment capacity of township hospitals and the travel time to a county hospital from different towns have differential impacts on the observed predictors. Therefore, we assumed that the obtained data indicated a hierarchical structure, and the 6,764 records could be aggregated by town level. The determinants of choice for hospital readmission were examined using multilevel binomial logistic regression analysis using MLwiN 2.30, which was developed by the University of Bristol, UK.[17] Patients were identified as level 1 and town as level 2. The regression model was as follows.

$$\begin{aligned}\operatorname{logit}(\pi_{ij}) = {} & \beta_{0j}\text{cons} + \beta_1\text{Admitted Year}_{ij} + \beta_2\text{Gender}_{ij} + \beta_3\text{Age}_{ij} + \beta_4\text{Distance}_{ij} + \beta_5\text{Time}_{ij} \\ & + \beta_6\text{Capacity}_{ij} + \beta_7 1^{st}\text{LOS}_{ij} + \beta_8 1^{st}\text{Expends}_{ij} + \beta_9\text{Interval}_{ij} + \text{More14}_{ij}\end{aligned} \quad (187)$$

$$\beta_{0j} = \beta_0 + u_{0j} \quad (188)$$

$\boldsymbol{\beta_i}$ refers to the fixed effects parameter, and $\boldsymbol{u_{oj}}$ refers to the random effects of level 2.

Patient and Public Involvement

No patients or public were involved in this research.

Ethical approval

The study protocol conformed to the guidelines of the Ethics Committee of the Tongji Medical College of Huazhong University of Science and Technology. The protocol was registered in the Chinese Clinical Trial Registry (ChiCTR-OOR-14005563). Patient information was anonymised and de-identified before analysis.

Results

Choices for hospital readmission after a first township hospitalisation

Among 271,405 discharged admissions in 2008–2013, there were 6,764 readmissions after a first hospitalisation in a township hospital. The TT group accounted for 62.5% (4,225) of all readmissions and the TC group for 37.5% (2,539) (Table 1).The number of readmissions increased sharply, whereas the proportion of readmissions in the total inpatients only changed slightly (5.0%). The TC group increased from 1.66% in 2008 to 1.89% in 2013, with the annual growth rate of the TC group being 28.55%, which was higher than that of the TT group (22.38%).

Table 1. Number of readmissions each year in Qianjiang district (2008–2013)

Year	All inpatients	Readmissions* n (%)	Choice for hospital readmission**		*P****
			TT group n (%)	TC group n (%)	
2008	21,823	524 (4.80)	342 (3.14)	182 (1.66)	<0.001
2009	34,240	1,076 (6.27)	724 (4.23)	352 (2.04)	
2010	35,866	942 (5.25)	608 (3.39)	334 (1.86)	
2011	50,616	1,260 (4.98)	797 (3.16)	463 (1.82)	
2012	61,467	1,384 (4.50)	815 (2.64)	569 (1.86)	
2013	67,392	1,578 (4.67)	939 (2.78)	639 (1.89)	
Total	271,405	6,764 (4.98)	4,225 (3.11)	2,539 (1.87)	

* Readmission refers to readmissions whose first admission was in a township hospital.

** One readmission includes two admissions.

*** Pearson's chi-square test.

Readmission varied among towns (Table 2). Chengnan town had the lowest overall readmission ratio (2.95%) and the lowest TT readmission ratio (1.52%) of the 30 towns. Heixi town had the lowest TC readmission ratio (1.30%), Shijia town had the highest TC readmission ratio (2.86%) and Jindong town had the highest TT readmission (5.49%) and overall readmission (6.96%) ratios.

Table 2. Number of readmissions Qianjiang district (2008–2013), by town

Town	All inpatients	Readmissions* n (%)	Choice for hospital readmission**		*P****
			TT group n (%)	TC group n (%)	
Chengnan	11,716	173 (2.95)	89 (1.52)	84 (1.43)	
Heixi	9,073	137 (3.02)	78 (1.72)	53 (1.30)	
Shaba	8,778	152 (3.20)	81 (1.58)	71 (1.62)	
~	~	~	~	~	<0.001
Shijia	8,605	223 (5.18)	100 (2.32)	123 (2.86)	
~	~	~	~	~	
Jindong	6,007	209 (6.96)	165 (5.49)	44 (1.47)	
Total	271,405	6,764 (4.98)	4225 (3.11)	2539 (1.87)	

* Readmission refers to readmissions whose first admission was in a township hospital.

** One readmission includes two admissions.

*** Pearson's chi-square test.

Characteristics of readmitted patients between TT and TC groups

Table 3 shows the characteristics of readmitted patients from 2008–2013. Male patients accounted for 48.7% of the TC group, which was a higher rate than in the TT group (41.9%, $P < 0.001$). Readmission choices varied in different age groups ($P< 0.001$), with over half (57.9%) of patients in the TC group aged 40–59 years. The most common interval between admissions in the TC group was shorter than 3 days (61.1%), whereas that in the TT group was 16–30 days (50.6%, $P < 0.001$). The average interval between admissions in the TC group was lower than that in TT group (6.03 days vs. 14.95 days). Similar patterns were observed in the average LOS of first inpatient admissions (6.96 days vs. 9.23 days) and

travel time to county hospital (59.73 minutes vs. 61.79 minutes). However, an opposite trend was observed in terms of expenses of first inpatient admission (¥831.35 vs. ¥791.01). The TC group mostly had respiratory (37.7%) and digestive diseases (20.3%). There were no significant differences in the distance to a county hospital and the township hospital capacity between the TT and TC groups.

Table 3. Distribution of characteristics of readmitted patients (*n* = 6,764)

Variable	All n (%)	Choice for hospital readmission		*P*
		TT group n (%)	TC group n (%)	
All	6,764	4,225 (62.5)	2539(37.5)	
Gender				<0.001*
Male	3,006 (44.4)	1769(41.9)	1237(48.7)	
Female	3,758(55.6)	2456(58.1)	1302(51.3)	
Age, years				
Mean (SD)	48.18 (0.27)	46.94(0.35)	50.25(0.43)	<0.001**
Less than 20	950 (22.0)	629(22.9)	321(20.5)	<0.001*
20–39	1,215 (28.2)	877(31.9)	338(21.6)	
40–59	2,045 (47.4)	1192(43.4)	853(54.4)	
More than 59	103 (2.4)	48(1.7)	55(3.5)	
Distance to CH (km)				
Mean (SD)	36.29 (0.27)	35.99(0.34)	36.78(0.42)	0.15**
Time to CH (min)				
Mean (SD)	60.51 (0.45)	59.73(0.57)	61.79(0.72)	0.03**
Capacity of TH				0.53*
1st level (Strong)	3,076 (45.5)	1918(45.4)	1158(45.6)	
2nd level (Better)	1,315 (19.4)	802(19)	513(20.2)	
3rd level (General)	9,35 (13.8)	591(14)	344(13.5)	
4th level (Weak)	1,438 (21.3)	914(21.6)	524(20.6)	
1st LOS (day)				
Mean (SD))	8.38 (0.12)	9.23(0.16)	6.96(0.16)	<0.001**
1st Expense (RMB)				
Mean (SD)	816.21 (7.94)	831.35(9.95)	791.01(13.14)	0.01**
2nd LOS (day)				
Mean (SD)	10.24 (0.13)	10.03(0.16)	10.58(0.22)	0.04**
2nd Expense (RMB)				
Mean (SD)	2215.49 (45.46)	862.99(12.77)	4466.09(104.99)	<0.001**

Interval between admissions (day)				
Mean (SD)	11.6 (0.12)	14.95(0.14)	6.03(0.17)	<0.001**
~3	2,133(31.5)	582(13.8)	1551(61.1)	<0.001*
3–7	761 (11.3)	517(12.2)	244(9.6)	
7–15	1,328 (19.6)	987(23.4)	341(13.4)	
16–31	2,542 (37.6)	2139(50.6)	403(15.9)	
Disease category				<0.001*
Cancer	178 (2.6)	109(2.6)	69(2.7)	
ENT disease	338 (5.0)	243(5.8)	95(3.7)	
Respiratory disease	2,673 (39.5)	1715(40.6)	958(37.7)	
Circulatory disease	450 (6.7)	224(5.3)	226(8.9)	
Digestive disease	984 (14.5)	469(11.1)	515(20.3)	
Urinary disease	269 (4.0)	89(2.1)	180(7.1)	
Haematological disorders	19 (0.2)	2(0.1)	17(0.7)	
Bones and muscles	425 (6.3)	218(5.2)	207(8.2)	
Obstetrics and gynaecology	1,213 (17.9)	1037(24.5)	176(6.9)	

* Pearson's chi-square test.

** ANOVA.

Determinants of choice for hospital readmission after township hospitalisation

The two-level logistic regression is illustrated by the level 2 variance of the zero model. This was statistically significant ($\chi^2 = 63.524$, $P < 0.001$), with aggregation of information at the town level. The specific results of the explanatory variables to fit the two variance component model are shown in Table 4. The major determinants of the choice for hospital readmission after a first township hospitalisation were admission year, age, travel time to a county hospital, interval between admissions, first LOS and disease category. If other factors remained constant, patients in the group aged 40–59 years were more likely to be readmitted to a county hospital (odds ratio [*OR*] = 1.32). Other factors associated with TC readmission were a shorter travel time to county hospital, shorter LOS, shorter interval between admissions, urinary tract diseases (*OR* = 2.68) or first admission/readmission in a

more recent year. The ratio of patients with obstetric or gynaecological diseases readmitted to a county hospital was much lower than that of patients with cancer (*OR* = 0.40).

Table 4. Multilevel logistic regression model for hospital readmission choice

	Parameter estimate	Standard error	χ^2	*P*	Adjusted OR
Fixed Part:					
Constant	−271.3	41.231	49.524	<0.001	
Admitted year*	0.136	0.027	47.934	<0.001	1.14
Gender(reference: female)					
Male	−0.003	0.066	0.003	0.955	1.00
Age (reference: less than 20)					
20–39	−0.062	0.123	0.250	0.617	0.94
40–59	0.294	0.111	6.870	0.008	1.32
More than 59	0.034	0.102	0.116	0.735	1.03
Travel time (min)	−0.023	0.013	17.468	<0.001	0.97
Capacity of TH**	−0.017	0.035	0.204	0.658	0.98
1st LOS (day)	−0.036	0.006	53.177	<0.001	0.96
1st Expends (RMB)	0.001	0.001	1.323	0.255	1.00
2nd LOS (day)	−0.002	0.003	0.213	0.644	0.99
Interval between admissions (day)	−0.110	0.004	895.49	<0.001	0.90
Disease category (reference: cancer)					
ENT	−0.406	0.263	2.462	0.131	0.67
Respiratory disease	−0.256	0.217	1.327	0.251	0.78
Circulatory disease	0.512	0.256	4.627	0.028	1.64
Digestive disease	0.553	0.227	6.217	0.013	1.74
Urinary disease	0.982	0.264	13.950	<0.001	2.68
Haematological disorders	2.310	0.853	7.641	0.004	10.03
Bones and muscles	0.245	0.242	1.066	0.301	1.28
Obstetrics and gynaecology	−0.947	0.238	15.874	<0.001	0.40
Else	−0.132	0.265	0.251	0.617	0.88
Random Part:					
Town variance	0.153	0.036	17.921	<0.001	—
Patient scale parameter	1	0.00	—	—	—

* TC shows a stable increase in recent years, so admitted year was included in the analysis by order of ranked data.

** Capacity of township hospital included in the analysis by order of ranked data.

Discussion

Choice for hospital readmission and aggregation

Readmission is common and unavoidable, and can often be attributed to technology and management problems.[18] TC readmission accounted for 1.89% of all hospitalisation cases in Qianjiang in 2013, showing steady growth from 2008 (1.67%). TC Readmission accounts for one-third of readmission cases had a first inpatient admission in a township hospital, which is common in rural China. However, as mentioned, TC readmission (either through doctor referral/recommendation or the patient's choice) often reflects an inefficient use of health services for patients; TC readmission patients may experience disease delays or cost waste, which may result in patient dissatisfaction regarding the township hospital. A point that needs to be noted here is the uncertainty about whether TT patients had been readmitted to a county hospital three or more times, which has been reported as a real scenario.

The two-level logistic regression analysis showed a hierarchy in the inpatient data (town–patients). Patients' choice of hospital readmission at the town level was clustered. In other words, 6,764 readmitted patients were non-independent, and the choices for hospital readmission in same town tended to be approximated. The incidence differed in different towns, from 2.95% (Chengnan) to 6.96% (Jindong). The 30 towns in the study area also differed in terms of township hospital, social customs and geographic location. Different township hospitals also have different service concepts and medical capabilities, which might have affected patients' hospital readmission choice.

Determinants of choice for hospital readmission

Logistic regression analysis showed that patient gender, capacity of township hospital and first admission expenses did not have significant effects on the choice of hospital for readmission. Readmission choice was affected by age, travel time to a county hospital, interval between admissions, LOS in the first admission and disease category. Although the towns in which patients lived affected their choice of hospital for readmission, the capacity of township hospitals had no significant effects; therefore, the town-based effects could be speculatively attributed to social customs and geographic location, which is consistent with a previous study.[19] In other words, regardless of capacity of the township hospital, readmission is unavoidable and prevalence under the same rate; in theory, TC readmission resulted from the doctors' assessment of their treatment ability, or deterioration of disease rather than the general hospital capacity.[20]

In general, patients were more likely to be readmitted to a county hospital if they were in an older age group, found travel to a county hospital more convenient, had lower expenses, had a shorter interval between admissions or diseases that were harder to assess. The ratio of patients choosing to be readmitted to a county hospital increased with age, which may be a result of the increased attention to the cure rate among those of more advanced age. The OR for travel time to a county hospital was 0.97, indicating that patients made their choice based on convenience.[16, 19] The most obvious influencing factors were first LOS and the interval between admissions. These factors need to be combined to discuss the difference in choice. The average first LOS in the TT group was 9.23 days, which is close to 9.7 days, the standard LOS in township hospitals in China.[15] Moreover, the average

interval between admissions was 14.95 days. In the TC group, the average first LOS was 6.96 days and the interval between admissions was 6.03 days. A shorter the first LOS (*OR* = 0.96) and a shorter the interval between admissions (*OR* = 0.90) was associated with a greater likelihood of choosing a county hospital. This disparity may be associated with the degree of urgency of the disease. Patients with diseases related to the urinary system (*OR* = 2.68) and haematological disorders (*OR* = 10.03) were more likely to choose a county hospital compared with patients with cancer, respiratory diseases and other disease types. This finding may be related to township doctor assessment regarding treatment ability. Diseases in the urinary system, cardiovascular system and haematological disorders cannot be controlled well in township hospitals, leading to a higher rate of inaccurate assessments and a higher probability of readmission to a county hospital.[21] Respiratory and digestive diseases (e.g. influenza, paediatric bronchial pneumonia and chronic obstructive pulmonary disease[22]) have a high incidence and recurrence rate and can be controlled in township hospitals. However, these diseases usually have failed treatment outcomes because of poor patient compliance on medicine and after-care.[23] Consequently, these patients may be more likely to choose township hospitals for readmission. Moreover, readmissions tended to move toward county hospitals as urgency increased (*OR* = 1.14), which implies an endogenous factor as affected the increase of inpatients in county hospitals in recent years.

Identifying forms of TC readmission

We could differentiate TC admission from TT admission by first LOS and interval between admissions. Intervals in TC patient admission showed a U-shaped distribution; 61.1% were

readmitted to a county hospital within 3 days, and a small prevalence peak appeared in the group after more than 15 days. Correspondently, 50.1% of patients in the TT group had an interval between admissions of more than 15 days. Therefore, a considerable proportion of early readmissions might be referrals; patients readmitted after a short first LOS with a short interval may be assumed to have been referred by doctors. A long first LOS and long interval were more likely to indicate a TC caused by individual choice, means an inappropriate TC readmission. Longer first LOS means a complete treatment in township hospital, and longer interval indicates readmission maybe been caused by poor compliance on medicine and after-cure from patients themselves or a normal disease recurrence.Therefore, a combination of first LOS and interval may be an effective identification index; we used 1 week as the cut-off value (Table 3). TC readmissions based on a doctor's incorrect assessment accounted for approximately 70.7% of admissions (interval between admissions <7 days), and those caused by patients accounted for 29.3% (interval between admissions >7 days).

The sample county is a typical rural area, and this research is a population based study, so the results could present the TC phenomenon in all rural China, and data process technical can also be used to different counties.

Conclusions

Patients were more likely to choose a county hospital for readmission in each study year. TC readmission remains a common health service use in rural China, and may result in inappropriate patient flows. Differences in readmission choices were associated with age,

travel time to county hospital, first LOS, interval between admissions and diseases; all of these factors are easy to identify. Combination of first LOS and interval between admissions could be an effective identification index for the forms of TC readmission.

Limitations

Our study has several limitations. Hospitalisation information, geographical factors, interval status and disease were all entered into the logistic regression model. However, some individual factors (e.g. economic status, education and preference) were not available. Moreover, influence on choice of hospitals may reflect an accumulated process, meaning that the more patients experience TC readmission, the more significant the influence would become. However, we only studied the influence of the first TC readmission in a single year. These limitations may bring instability to our study and need to be resolved in future studies.

Competing interests

The authors have declared that no competing interests exist.

Authors' contributions

Y.Z. and L.Z. participated in conception and design, and the analyses, and wrote the manuscript. Y-D.N. participated in data collection and performed the statistical analysis. L.Z. helped to draft the manuscript, reviewed the manuscript and made final changes. All authors have given their final approval of the version to be published.

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Data sharing statement

The anonymized dataset is available through the email of the corresponding author.

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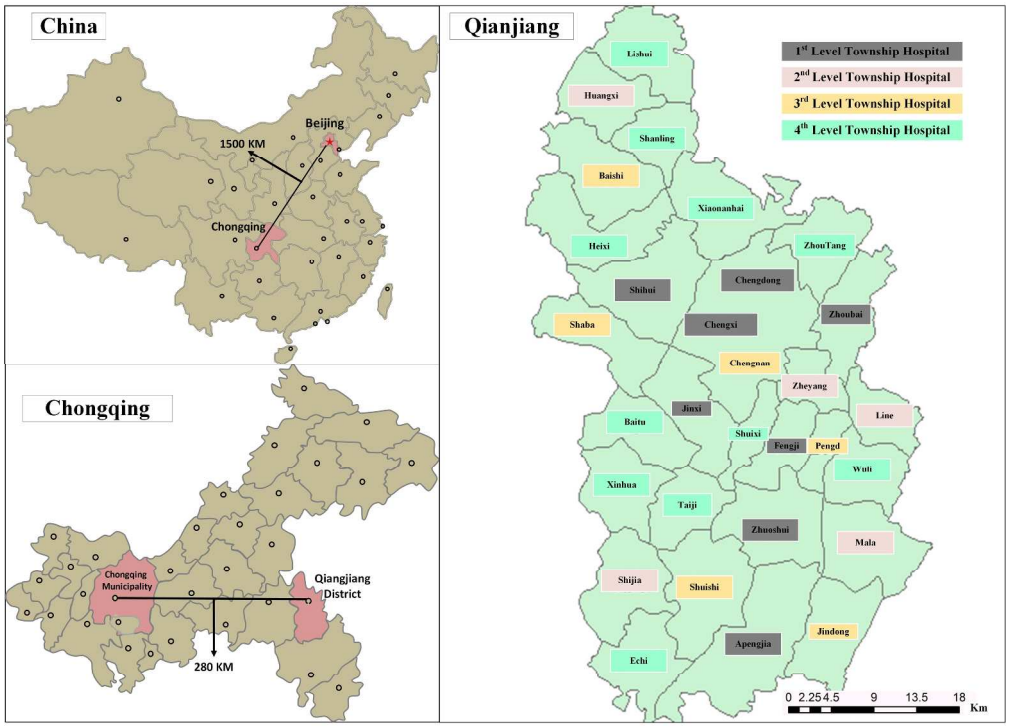
Figure Legend

Figure 1. Map of Qianjiang distract: geographic distribution



Map of Qianjiang distract: geographic distribution

136x113mm (600 x 600 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on Line #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	**Lines:1-2**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	**Lines:22-58**
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	**Lines:60-126**
Objectives	3	State specific objectives, including any prespecified hypotheses	**Lines:126-129**
Methods			
Study design	4	Present key elements of study design early in the paper	**Lines:152-154**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	**Lines:131-143**
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	**Lines:145-147**
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	**Lines:148-152**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	**Lines:152-166**
Bias	9	Describe any efforts to address potential sources of bias	**No**
Study size	10	Explain how the study size was arrived at	**Lines:167-168**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	**Lines:169-177**
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	**Lines:178-180**
		(*b*) Describe any methods used to examine subgroups and interactions	**Lines:180-190**
		(*c*) Explain how missing data were addressed	**No**
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	**No**
		(*e*) Describe any sensitivity analyses	**No**
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	**Lines:197-204**
		(b) Give reasons for non-participation at each stage	**No**
		(c) Consider use of a flow diagram	**No**
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	**Lines:218-234**
		(b) Indicate number of participants with missing data for each variable of interest	**No**
Outcome data	15*	Report numbers of outcome events or summary measures	**Lines:198-201**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	**Lines:235-250**
		(*b*) Report category boundaries when continuous variables were categorized	**Lines:235-250**
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	**No**
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	**Lines:209-217**
Discussion			
Key results	18	Summarise key results with reference to study objectives	**Lines:252-271; 332-338**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	**Lines:339-347**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	**Lines:272-328**
Generalisability	21	Discuss the generalisability (external validity) of the study results	**Lines:329-331**
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	**Lines:356-357**

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Determinants of Patient Choice for Hospital Readmission after Township Hospitalisation: A Population-Based Retrospective Study in China

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Determinants of Patient Choice for Hospital Readmission after Township Hospitalisation: A Population-Based Retrospective Study in China

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Abstract

Objective: The lack of coordinated and appropriate healthcare across sectors has produced more patients for county hospitals in China. This study examined differences in patient choice between township and county hospitals for readmission after a first township hospitalisation, and the determinants that influenced this choice.

Design: A retrospective study of readmissions across hospitals after a first admission in township hospital. A township–township inpatient (TT) group and a township–county inpatient (TC) group were compared. A two-level logistic regression model was used to examine the determinants of choice for hospital readmission.

Setting: Data were drawn from a population-based health utilisation database for Qianjiang District, China, from 1 January 2008 to 31 December 2013.

Participants: This study focused on readmitted patients whose first admission was in a township hospital. Readmission cases were identified as the same diagnosis (International Classification of Diseases, tenth revision) in a subsequent hospitalisation within 30 days. In total, 6,764 readmissions had first admissions in township hospitals.

Primary outcome measures: Patient choice for hospital readmission after a first township hospitalisation.

Results: The TT group accounted for 62.5% (4,225) and the TC group for 37.5% (2,539) of readmissions in 6 years. Readmission rates varied among towns ($P < 0.001$). Differences between the TC and TT groups included: length of stay (LOS) of first admission (6.96 days vs. 9.23 days), average interval between admissions (6.03 days vs. 14.95 days) and disease category. Admission year, age, travel time to county hospital, interval between admissions,

first admission LOS and disease category were determinants of choice for hospital readmission.

Conclusions: Patients whose first admission was in a township hospital were more likely to be readmitted to a county hospital. A combination of first LOS and interval between admissions may be an effective identification index for township–county readmission.

Keywords: readmission, choice, county hospital, patient flow, rural China

Strengths and limitations

- This is the first study to focus on township-county readmission, a feature of hospitalisation in rural China.
- Population-level data on readmission is seldom reported across hospitals of different levels.
- Programming techniques, including Microsoft Excel formulas and case processing technologies, were used in the data processing.
- A two-level logistic regression model was used to consider aggregation at the town level.
- Hospitalisation information, geographical factors, interval status and disease were all entered into the logistic regression model, but some individual factors were missing.

Background

Readmission refers to an episode where an inpatient is readmitted for the same disease with 30 days.[1, 2] In most studies, readmission findings reflect that inpatient care did not meet patient requirements, with readmission rates used as an evaluation index for hospitalisation quality.[3] Readmission usually occurs in the same hospital, but sometimes

occurs across hospitals because of deterioration of a patient's disease.[4] However, in rural China, multilevel institutional readmission is a common and important healthcare utilisation. This reflects defects of China's healthcare delivery system, rather than hospitalisation quality, especially in township–county (TC) readmissions. TC readmission is a health-seeking behaviour in which inpatients seek healthcare services in a township hospital first, and then in a county hospital, whether planned or unplanned, voluntarily or passively. TC readmission is frequent in rural China, and currently accounts for approximately 2.0% of all inpatient services.[5] TC readmission usually occurs following doctor recommendation/referral or by individual patient choice.

TC readmission recommended by doctors occurs when a township doctor has an inpatient admission that they cannot fully treat or completely cure;[6] consequently, that patient is referred directly to a county hospital or advised to go to a county hospital for subsequent admission.[6] This situation results from the three-tier healthcare delivery system in rural China, where care is provided in a village–town–county healthcare delivery system, and all hospital services are supplied by township and county hospitals.[7] In general, the higher the level of the institution, the stronger the service capability, the greater the distance a patient must travel and the higher the medical cost. Township hospitals bear the responsibilities of transferring patients, taking care of inpatients with general illnesses and advising patients with severe diseases (that are beyond their capacity) to seek admission at county hospitals.[8] Township hospital doctors sometimes receive patients whose diseases are beyond their capacity to manage (e.g. because of their inaccurate judgment, or deterioration of the disease), meaning TC readmission may be unavoidable.

TC readmission from individual choice may occur when patients who should be readmitted to township hospitals choose to be admitted to county hospitals for personal reasons.[9] Some readmissions are influenced by quality concerns with township hospitals, poor patient compliance on medicine and after-care or from a normal disease recurrence. However, patients often do not acknowledge the real readmission reason and transfer responsibility for readmission to the township hospital doctor (e.g. considering readmission as a result of failed treatment) and consequently decide to be readmitted to a county hospital. This situation often represents inappropriate readmission.[10]

From the patients' perspective, no order or limitation on patient choice exists. In addition, no general practitioners or consultants are available in rural China. Therefore, residents freely choose hospitals and service types, mainly depending on their judgment regarding their disease and understanding of hospitals. If a patient chooses a higher-level institution than necessary, they pay more; if they choose a lower-level institution than necessary they would be referred or readmitted. Therefore, the cost of an incorrect decision is borne by the patient. To guarantee patient interests regarding TC readmission, the three-tier healthcare delivery system requires different-level hospitals to cooperate in providing continuous healthcare services. However, in reality, communication among township and county professional providers is limited, and there is virtually no document sharing or interaction among providers across the three tiers.[11] County hospital doctors do not deliver continued care for readmitted patients because of income incentives and risk aversion, and patients readmitted to a county hospital usually receive new treatment.[12] Furthermore, compared with patients admitted directly to county hospitals, readmitted patients spend

more time, pay more costs and may even miss proper treatments. As a result, when subsequent illnesses occur and patients are unable to judge the severity of their illness, they tend to choose admission in a county hospital, taking excess economic risk to avoid delay. Some studies have defined TC readmission as failed treatment from the patients' perspective, and shown that the TC readmission experience can influence a patient's later choice of hospital.[13, 14] Inpatients may be more likely to seek care in county hospitals compared with township hospitals; a phenomenon that is already happening. The annual growth rate of inpatients in county hospitals from 2010 to 2016 was 6.75%, whereas that of township hospital inpatients was 0.63% in rural China.[15]

As noted, TC readmission from individual choice may be an inappropriate level of admission, and TC readmission recommended by doctors can also result in inappropriate level admission for subsequent hospitalisation. Inappropriate level admission means patients seek healthcare in a higher-level hospital than necessary. This may result from patients' intentional institution selection and distrust of the capability of township hospitals; such patients prefer to spend more money on healthcare to avoid the risk of needing referral. Inappropriate level admission is a major form of excess service demand,[12] and an important determinant of increasing health expenditure that leads to significant waste. In this context, identifying the forms and determinants of TC readmission will help to improve the New Rural Cooperative Medical System (NRCMS). This study focused on choices for hospital readmission after a first admission as an inpatient in a township hospital, and identified the determinants of choice for hospital readmission.

Methods

Study setting

Qianjiang District was designated as the sample area through cluster sampling. This is a typical rural area located in Chongqing, which is the largest municipality in southwest China. Qianjiang has a per capita GDP of $7,515 in 2016, which is below the average GDP in China. The resident population is 550,000 people; all residents are covered under the NRCMS, and are eligible to receive reimbursement for inpatient care. Qiangjiang District has two county hospitals and 30 township hospitals. The township hospitals are divided into four levels according to their scale and service quantity by Qianjiang Health Bureau (Fig. 1). First-level township hospitals are allocated more than 30 beds and may perform abdominal operations; these hospitals had more than 1,200 discharged patients in 2013. Second-level township hospitals cannot perform abdominal operations of the same scale as first-level township hospitals. Third-level township hospitals have fewer than 30 beds and around 600~1,200 discharged patients. All other township hospitals belong to the fourth level.

Data source

This study was based on the NRCMS inpatient database in Qianjiang District, which contains all inpatient data for the population. In this database, a case refers to a single hospitalisation in a county or township hospitals.

Data processing

We focused on individuals who had been discharged from participating hospitals. Readmission cases were identified as having the same diagnosis in subsequent hospitalisations between county and township hospitals or township hospitals and township hospitals within 30 days. Given our population-based retrospective design, we compared the differences between township–township readmitted inpatients (TT group) and TC readmitted inpatients (TC group). Samples were entered into MS Excel 2010, based on the NRCMS database from 1 January 2008 to 31 December 2013. First, cases that shared the same patient identifier and the same disease codes were sorted in chronological order. Second, we calculated the interval between admissions in two adjacent cases for the same inpatient for the same disease; if the interval between admissions was less than 31 days, the patient was marked as a readmission patient. For example, if the first admission occurred in a township hospital and the second occurred in county hospital, the two cases would be merged as one case and marked as a TC readmission, and the patient marked as TC patient. TT patients were identified in a similar manner. Finally, all TC and TT cases were extracted into a new database. As diagnosis of a disease may change among different doctors, in different institutions or at different times, we adjusted the original International

Classification of Diseases, tenth revision disease code into a broader code (e.g. chronic obstructive pulmonary disease was adjusted from J44.900 to J44), which may improve accuracy in identifying readmitted patients. After screening, there were 6,764 readmitted patients from 2008–2013 in the sample.

The main programming techniques included Microsoft Excel formulas (e.g. COUNTIF, SUMPRODUCT, LOOKUP and IF) and case processing technologies (e.g. split columns and removal of duplicates).

Sociological characteristics were collected to build a final database, including: gender; age; travel time from home to county hospital; first inpatient information including length of stay (LOS), expenses, disease category, capacity of the township hospital, interval between admissions and readmitted hospital choice.[16] The distance and travel time to the county hospital for all readmitted patients were captured individually by Google Maps. Because traffic conditions are different in different towns (e.g. national roads, provincial roads or county roads), both the distance and travel time were captured.

Data obtained and Statistical analysis

The characteristics of patients' choices for hospital readmission were compared using t-tests and chi-square tests in IBM SPSS Statistics 22.0. The treatment capacity of township hospitals and the travel time to a county hospital from different towns have differential impacts on the observed predictors. Therefore, we assumed that the obtained data indicated a hierarchical structure, and the 6,764 records could be aggregated by town level. The determinants of choice for hospital readmission were examined using multilevel binomial logistic regression analysis using MLwiN 2.30, which was developed by the

University of Bristol, UK.[17] Patients were identified as level 1 and town as level 2. The regression model was as follows.

$$\log it(\pi_{ij}) = \beta_{0j}\text{cons} + \beta_1\text{Admitted Year}_{ij} + \beta_2\text{Gender}_{ij} + \beta_3\text{Age}_{ij} + \beta_4\text{Distance}_{ij} + \beta_5\text{Time}_{ij} + \beta_6\text{Capacity}_{ij} + \beta_7 1^{st}\text{LOS}_{ij} + \beta_8 1^{st}\text{Expends}_{ij} + \beta_9\text{Interval}_{ij} + \text{More14}_{ij}$$

$$\beta_{0j} = \beta_0 + u_{0j}$$

$\boldsymbol{\beta_i}$ refers to the fixed effects parameter, and $\boldsymbol{u_{oj}}$ refers to the random effects of level 2.

Patient and Public Involvement

No patients or public were involved in this research.

Ethical approval

The study protocol conformed to the guidelines of the Ethics Committee of the Tongji Medical College of Huazhong University of Science and Technology. The protocol was registered in the Chinese Clinical Trial Registry (ChiCTR-OOR-14005563). Patient information was anonymised and de-identified before analysis.

Results

Choices for hospital readmission after a first township hospitalisation

Among 271,405 discharged admissions in 2008–2013, there were 6,764 readmissions after a first hospitalisation in a township hospital. The TT group accounted for 62.5% (4,225) of all readmissions and the TC group for 37.5% (2,539) (Table 1).The number of readmissions increased sharply, whereas the proportion of readmissions in the total inpatients averaging around 5%. The TC group increased from 1.66% in 2008 to 1.89% in 2013, with the annual growth rate of the TC group being 28.55%, which was higher than

that of the TT group (22.38%).

Table 1. Number of readmissions each year in Qianjiang district (2008–2013)

Year	All inpatients	Readmissions* n (%)	Choice for hospital readmission**		*P****
			TT group n (%)	TC group n (%)	
2008	21,823	524 (4.80)	342 (3.14)	182 (1.66)	<0.001
2009	34,240	1,076 (6.27)	724 (4.23)	352 (2.04)	
2010	35,866	942 (5.25)	608 (3.39)	334 (1.86)	
2011	50,616	1,260 (4.98)	797 (3.16)	463 (1.82)	
2012	61,467	1,384 (4.50)	815 (2.64)	569 (1.86)	
2013	67,392	1,578 (4.67)	939 (2.78)	639 (1.89)	
Total	271,405	6,764 (4.98)	4,225 (3.11)	2,539 (1.87)	

* Readmission refers to readmissions whose first admission was in a township hospital.

** One readmission includes two admissions.

*** Pearson's chi-square test.

Readmission varied among towns (Table 2). Chengnan town had the lowest overall readmission ratio (2.95%) and the lowest TT readmission ratio (1.52%) of the 30 towns. Heixi town had the lowest TC readmission ratio (1.30%), Shijia town had the highest TC readmission ratio (2.86%) and Jindong town had the highest TT readmission (5.49%) and overall readmission (6.96%) ratios.

Table 2. Number of readmissions Qianjiang district (2008–2013), by town

Town	All inpatients	Readmissions* n (%)	Choice for hospital readmission**		*P****
			TT group n (%)	TC group n (%)	
Chengnan	11,716	173 (2.95)	89 (1.52)	84 (1.43)	<0.001
Heixi	9,073	137 (3.02)	78 (1.72)	53 (1.30)	
Shaba	8,778	152 (3.20)	81 (1.58)	71 (1.62)	
~	~	~	~	~	
Shijia	8,605	223 (5.18)	100 (2.32)	123 (2.86)	
Jindong	6,007	209 (6.96)	165 (5.49)	44 (1.47)	
Total	271,405	6,764 (4.98)	4225 (3.11)	2539 (1.87)	

* Readmission refers to readmissions whose first admission was in a township hospital.

** One readmission includes two admissions.

*** Pearson's chi-square test.

Characteristics of readmitted patients between TT and TC groups

Table 3 shows the characteristics of readmitted patients from 2008–2013. Male patients accounted for 48.7% of the TC group, which was a higher rate than in the TT group (41.9%, $P < 0.001$). Readmission choices varied in different age groups ($P< 0.001$), with over half (57.9%) of patients in the TC group aged 40–59 years. The most common interval between admissions in the TC group was shorter than 3 days (61.1%), whereas that in the TT group was 16–30 days (50.6%, $P < 0.001$). The average interval between admissions in the TC group was lower than that in TT group (6.03 days vs. 14.95 days). Similar patterns were observed in the average LOS of first inpatient admissions (6.96 days vs. 9.23 days) and travel time to county hospital (59.73 minutes vs. 61.79 minutes). However, an opposite trend was observed in terms of expenses of first inpatient admission (¥831.35 vs. ¥791.01). The TC group mostly had respiratory (37.7%) and digestive diseases (20.3%). There were no significant differences in the distance to a county hospital and the township hospital capacity between the TT and TC groups.

Table 3. Distribution of characteristics of readmitted patients (*n* = 6,764)

Variable	All n (%)	Choice for hospital readmission		*P*
		TT group n (%)	TC group n (%)	
All	6,764	4,225 (62.5)	2539(37.5)	
Gender				<0.001*
Male	3,006 (44.4)	1769(41.9)	1237(48.7)	
Female	3,758(55.6)	2456(58.1)	1302(51.3)	
Age, years				
Mean (SD)	48.18 (0.27)	46.94(0.35)	50.25(0.43)	<0.001**
Less than 20	950 (22.0)	629(22.9)	321(20.5)	<0.001*
20–39	1,215 (28.2)	877(31.9)	338(21.6)	
40–59	2,045 (47.4)	1192(43.4)	853(54.4)	
More than 59	103 (2.4)	48(1.7)	55(3.5)	
Distance to CH (km)				

Mean (SD)	36.29 (0.27)	35.99(0.34)	36.78(0.42)	0.15**
Time to CH (min)				
Mean (SD)	60.51 (0.45)	59.73(0.57)	61.79(0.72)	0.03**
Capacity of TH				0.53*
1st level (Strong)	3,076 (45.5)	1918(45.4)	1158(45.6)	
2nd level (Better)	1,315 (19.4)	802(19)	513(20.2)	
3rd level (General)	9,35 (13.8)	591(14)	344(13.5)	
4th level (Weak)	1,438 (21.3)	914(21.6)	524(20.6)	
1st LOS (day)				
Mean (SD))	8.38 (0.12)	9.23(0.16)	6.96(0.16)	<0.001**
1st Expense (RMB)				
Mean (SD)	816.21 (7.94)	831.35(9.95)	791.01(13.14)	0.01**
2nd LOS (day)				
Mean (SD)	10.24 (0.13)	10.03(0.16)	10.58(0.22)	0.04**
2nd Expense (RMB)				
Mean (SD)	2215.49 (45.46)	862.99(12.77)	4466.09(104.99)	<0.001**
Interval between admissions (day)				
Mean (SD)	11.6 (0.12)	14.95(0.14)	6.03(0.17)	<0.001**
~3	2,133(31.5)	582(13.8)	1551(61.1)	<0.001*
3–7	761 (11.3)	517(12.2)	244(9.6)	
7–15	1,328 (19.6)	987(23.4)	341(13.4)	
16–31	2,542 (37.6)	2139(50.6)	403(15.9)	
Disease category				<0.001*
Cancer	178 (2.6)	109(2.6)	69(2.7)	
ENT disease	338 (5.0)	243(5.8)	95(3.7)	
Respiratory disease	2,673 (39.5)	1715(40.6)	958(37.7)	
Circulatory disease	450 (6.7)	224(5.3)	226(8.9)	
Digestive disease	984 (14.5)	469(11.1)	515(20.3)	
Urinary disease	269 (4.0)	89(2.1)	180(7.1)	
Haematological disorders	19 (0.2)	2(0.1)	17(0.7)	
Bones and muscles	425 (6.3)	218(5.2)	207(8.2)	
Obstetrics and gynaecology	1,213 (17.9)	1037(24.5)	176(6.9)	

* Pearson's chi-square test.

** ANOVA.

Determinants of choice for hospital readmission after township hospitalisation

The two-level logistic regression is illustrated by the level 2 variance of the zero model.

This was statistically significant ($\chi^2 = 63.524$, $P < 0.001$), with aggregation of information at the town level. The specific results of the explanatory variables to fit the two variance component model are shown in Table 4. The major determinants of the choice for hospital readmission after a first township hospitalisation were admission year, age, travel time to a county hospital, interval between admissions, first LOS and disease category. If other factors remained constant, patients in the group aged 40–59 years were more likely to be readmitted to a county hospital (odds ratio [*OR*] = 1.32). Other factors associated with TC readmission were a shorter travel time to county hospital, shorter LOS, shorter interval between admissions, urinary tract diseases (*OR* = 2.68) or first admission/readmission in a more recent year. The ratio of patients with obstetric or gynaecological diseases readmitted to a county hospital was much lower than that of patients with cancer (*OR* = 0.40).

Table 4. Multilevel logistic regression model for hospital readmission choice

	Parameter estimate	Standard error	χ^2	*P*	Adjusted OR
Fixed Part:					
Constant	−271.3	41.231	49.524	<0.001	
Admitted year*	0.136	0.027	47.934	<0.001	1.14
Gender(reference: female)					
Male	−0.003	0.066	0.003	0.955	1.00
Age (reference: less than 20)					
20–39	−0.062	0.123	0.250	0.617	0.94
40–59	0.294	0.111	6.870	0.008	1.32
More than 59	0.034	0.102	0.116	0.735	1.03
Travel time (min)	−0.023	0.013	17.468	<0.001	0.97
Capacity of TH**	−0.017	0.035	0.204	0.658	0.98
1st LOS (day)	−0.036	0.006	53.177	<0.001	0.96
1st Expends (RMB)	0.001	0.001	1.323	0.255	1.00
2nd LOS (day)	−0.002	0.003	0.213	0.644	0.99
Interval between admissions (day)	−0.110	0.004	895.49	<0.001	0.90
Disease category (reference: cancer)					

ENT	−0.406	0.263	2.462	0.131	0.67
Respiratory disease	−0.256	0.217	1.327	0.251	0.78
Circulatory disease	0.512	0.256	4.627	0.028	1.64
Digestive disease	0.553	0.227	6.217	0.013	1.74
Urinary disease	0.982	0.264	13.950	<0.001	2.68
Haematological disorders	2.310	0.853	7.641	0.004	10.03
Bones and muscles	0.245	0.242	1.066	0.301	1.28
Obstetrics and gynaecology	−0.947	0.238	15.874	<0.001	0.40
Else	−0.132	0.265	0.251	0.617	0.88
Random Part:					
Town variance	0.153	0.036	17.921	<0.001	—
Patient scale parameter	1	0.00	—	—	—

* TC shows a stable increase in recent years, so admitted year was included in the analysis by order of ranked data.

** Capacity of township hospital included in the analysis by order of ranked data.

Discussion

Choice for hospital readmission and aggregation

Readmission is common and unavoidable, and can often be attributed to technology and management problems.[18] TC readmission accounted for 1.89% of all hospitalisation cases in Qianjiang in 2013, showing steady growth from 2008 (1.66%). In the study period, TC readmission accounted for more than one-third of readmission cases that had a first inpatient admission in a township hospital, which is common in rural China. However, as mentioned, TC readmission (either through doctor referral/recommendation or the patient's choice) often reflects an inefficient use of health services for patients; TC readmission patients may experience disease delays or cost waste, which may result in patient dissatisfaction regarding the township hospital. A point that needs to be noted here is the uncertainty about whether TT patients had been readmitted to a county hospital three or more times, which has been reported as a real scenario.

The two-level logistic regression analysis showed a hierarchy in the inpatient data (town–patients). Patients' choice of hospital readmission was clustered at the town level. In other words, 6,764 readmitted patients were non-independent, and the choices for hospital readmission in same town tended to be approximated. The incidence differed in different towns, from 2.95% (Chengnan) to 6.96% (Jindong). The 30 towns in the study area also differed in terms of township hospital, social customs and geographic location. Different township hospitals also have different service concepts and medical capabilities, which might have affected patients' hospital readmission choice.

Determinants of choice for hospital readmission

Logistic regression analysis showed that patient gender, capacity of township hospital and first admission expenses did not have significant effects on the choice of hospital for readmission. Readmission choice was affected by age, travel time to a county hospital, interval between admissions, LOS in the first admission and disease category. Although the towns in which patients lived affected their choice of hospital for readmission, the capacity of township hospitals had no significant effects; therefore, the town-based effects could be speculatively attributed to social customs and geographic location, which is consistent with a previous study.[19] In other words, regardless of capacity of the township hospital, readmission is unavoidable and occurs under the same rate; in theory, TC readmission resulted from the doctors' assessment of their treatment ability, or deterioration of disease rather than the general hospital capacity.[20]

In general, patients were more likely to be readmitted to a county hospital if they were in

an older age group, found travel to a county hospital more convenient, had lower expenses, had a shorter interval between admissions or diseases that were harder to assess. The ratio of patients choosing to be readmitted to a county hospital increased with age, which may be a result of the increased attention to the cure rate among those of more advanced age. The OR for travel time to a county hospital was 0.97, indicating that patients made their choice based on convenience.[16, 19] The most obvious influencing factors were first LOS and the interval between admissions. These factors can be combined to discuss the difference in choice. The average first LOS in the TT group was 9.23 days, which is close to 9.7 days, the standard LOS in township hospitals in China.[15] Moreover, the average interval between admissions was 14.95 days. In the TC group, the average first LOS was 6.96 days and the interval between admissions was 6.03 days. A shorter first LOS (*OR* = 0.96) and a shorter the interval between admissions (*OR* = 0.90) was associated with a greater likelihood of choosing a county hospital. This disparity may be associated with the degree of urgency of the disease. Patients with diseases related to the urinary system (*OR* = 2.68) and haematological disorders (*OR* = 10.03) were more likely to choose a county hospital compared with patients with cancer, respiratory diseases and other disease types. This finding may be related to township doctor assessment regarding treatment ability. Diseases in the urinary system, cardiovascular system and haematological disorders cannot be controlled well in township hospitals, leading to a higher rate of inaccurate assessments and a higher probability of readmission to a county hospital.[21] Respiratory and digestive diseases (e.g. influenza, paediatric bronchial pneumonia and chronic obstructive pulmonary disease[22]) have a high incidence and recurrence rate and can be controlled in

township hospitals. However, these diseases often have failed treatment outcomes because of poor patient compliance on medicine and after-care.[23] Consequently, these patients may be more likely to choose county hospitals for readmission. Moreover, readmissions tended to move toward county hospitals as year increased (*OR* = 1.14), which implies an endogenous factor as affected the increase of inpatients in county hospitals in recent years.

Identifying forms of TC readmission

We could differentiate TC admission from TT admission by first LOS and interval between admissions. Intervals in TC patient admission showed a U-shaped distribution; 61.1% were readmitted to a county hospital within 3 days, and a small prevalence peak appeared in the group after more than 15 days. Correspondently, 50.1% of patients in the TT group had an interval between admissions of more than 15 days. Therefore, a considerable proportion of early readmissions might be referrals; patients readmitted after a short first LOS with a short interval may be assumed to have been referred by doctors. A long first LOS and long interval were more likely to indicate a TC caused by individual choice, meaning an inappropriate TC readmission. Longer first LOS means a complete treatment in township hospital, and longer interval indicates readmission may have been caused by poor compliance on medicine and after-care from patients themselves or a normal disease recurrence.Therefore, a combination of first LOS and interval may be an effective identification index; we used 1 week as the cut-off value (Table 3). TC readmissions based on a doctor's incorrect assessment accounted for approximately 70.7% of admissions (interval between admissions <7 days), and those caused by patients accounted for 29.3% (interval between admissions >7 days).

The sample county is a typical rural area, and this research is a population based study, so the results could present the TC phenomenon in all rural China.

Conclusions

Patients were more likely to choose a county hospital for readmission over time. TC readmission remains a common health service use in rural China, and may result in inappropriate patient flows. Differences in readmission choices were associated with age, travel time to county hospital, first LOS, interval between admissions and diseases; all of these factors are easy to identify. Combination of first LOS and interval between admissions could be an effective identification index for the forms of TC readmission.

Limitations

Our study has several limitations. Hospitalisation information, geographical factors, interval status and disease were all entered into the logistic regression model. However, some individual factors (e.g. economic status, education and preference) were not available. Moreover, influence on choice of hospitals may reflect an accumulated process, meaning that the more patients experience TC readmission, the more significant the influence would become. However, we only studied the influence of the first TC readmission in a single year. These limitations may bring instability to our study and need to be resolved in future studies.

Competing interests

The authors have declared that no competing interests exist.

Authors' contributions

Y.Z. and L.Z. participated in conception and design, and the analyses, and wrote the manuscript. Y-D.N. participated in data collection and performed the statistical analysis. L.Z. helped to draft the manuscript, reviewed the manuscript and made final changes. All authors have given their final approval of the version to be published.

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Disclosure

No past publication history, no past presentation history

Provenance and peer review

Not commissioned; externally peer reviewed.

Data sharing statement

The anonymized dataset is available through the email of the corresponding author.

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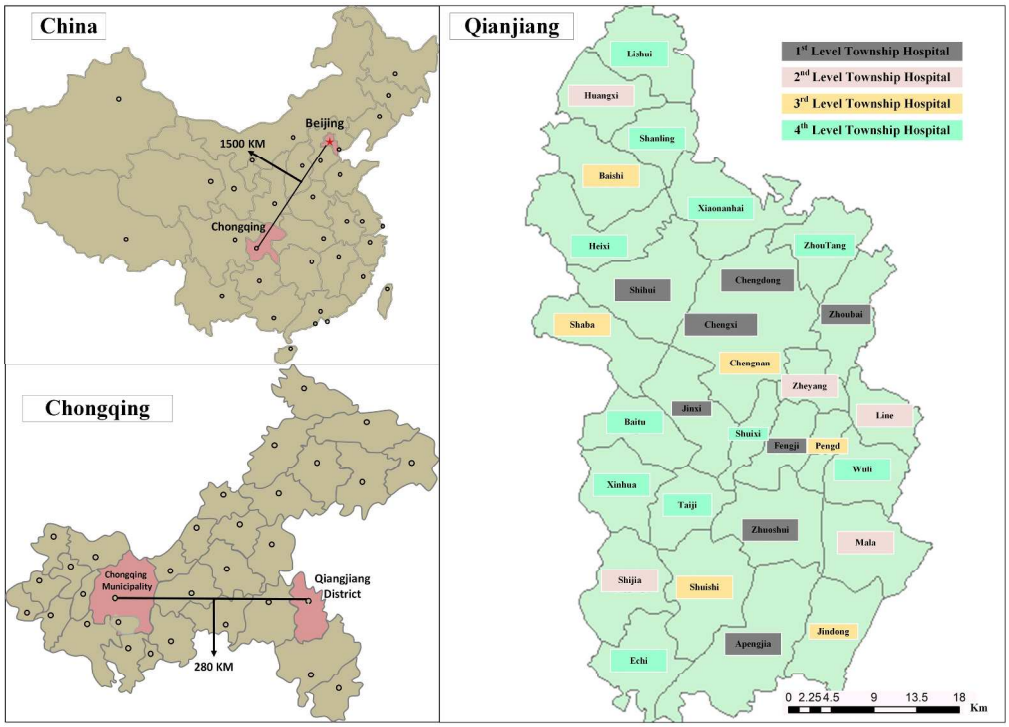
Figure Legend

Figure 1. Map of Qianjiang distract: geographic distribution



Map of Qianjiang distract: geographic distribution

136x113mm (600 x 600 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on Line #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	**Lines:1-2**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	**Lines:22-58**
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	**Lines:60-126**
Objectives	3	State specific objectives, including any prespecified hypotheses	**Lines:126-129**
Methods			
Study design	4	Present key elements of study design early in the paper	**Lines:152-154**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	**Lines:131-143**
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	**Lines:145-147**
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	**Lines:148-152**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	**Lines:152-166**
Bias	9	Describe any efforts to address potential sources of bias	**No**
Study size	10	Explain how the study size was arrived at	**Lines:167-168**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	**Lines:169-177**
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	**Lines:178-180**
		(*b*) Describe any methods used to examine subgroups and interactions	**Lines:180-190**
		(*c*) Explain how missing data were addressed	**No**
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	**No**
		(*e*) Describe any sensitivity analyses	**No**
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	**Lines:197-204**
		(b) Give reasons for non-participation at each stage	**No**
		(c) Consider use of a flow diagram	**No**
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	**Lines:218-234**
		(b) Indicate number of participants with missing data for each variable of interest	**No**
Outcome data	15*	Report numbers of outcome events or summary measures	**Lines:198-201**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	**Lines:235-250**
		(*b*) Report category boundaries when continuous variables were categorized	**Lines:235-250**
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	**No**
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	**Lines:209-217**
Discussion			
Key results	18	Summarise key results with reference to study objectives	**Lines:252-271; 332-338**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	**Lines:339-347**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	**Lines:272-328**
Generalisability	21	Discuss the generalisability (external validity) of the study results	**Lines:329-331**
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	**Lines:356-357**

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Determinants of Patient Choice for Hospital Readmission after Township Hospitalisation: A Population-Based Retrospective Study in China

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Abstract

Objective: The lack of coordinated and appropriate healthcare across sectors has produced more patients for county hospitals in China. This study examined differences in patient choice between township and county hospitals for readmission after a first township hospitalisation, and the determinants that influenced this choice.

Design: A retrospective study of readmissions across hospitals after a first admission in township hospital. A township–township inpatient (TT) group and a township–county inpatient (TC) group were compared. A two-level logistic regression model was used to examine the determinants of choice for hospital readmission.

Setting: Data were drawn from a population-based health utilisation database for Qianjiang District, China, from 1 January 2008 to 31 December 2013.

Participants: This study focused on readmitted patients whose first admission was in a township hospital. Readmission cases were identified as the same diagnosis (International Classification of Diseases, tenth revision) in a subsequent hospitalisation within 30 days. In total, 6,764 readmissions had first admissions in township hospitals.

Primary outcome measures: Patient choice for hospital readmission after a first township hospitalisation.

Results: The TT group accounted for 62.5% (4,225) and the TC group for 37.5% (2,539) of readmissions in 6 years, and the proportion of TC readmissions in total inpatients increased from 1.66% to 1.89%. Readmission rates varied among towns ($P < 0.001$). Differences between the TC and TT groups included: length of stay (LOS) of first admission (6.96 days vs. 9.23 days), average interval between admissions (6.03 days vs.

14.95 days) and disease category. Admission year, age, travel time to county hospital, interval between admissions, first admission LOS and disease category were determinants of choice for hospital readmission.

Conclusions: Patients whose first admission was in a township hospital were more likely to be readmitted to a county hospital. A combination of first LOS and interval between admissions may be an effective identification index for township–county readmission.

Keywords: readmission, choice, county hospital, patient flow, rural China

Strengths and limitations

- This is the first study to focus on township-county readmission, a feature of hospitalisation in rural China.
- Population-level data on readmission is seldom reported across hospitals of different levels.
- Programming techniques, including Microsoft Excel formulas and case processing technologies, were used in the data processing.
- A two-level logistic regression model was used to consider aggregation at the town level.
- Hospitalisation information, geographical factors, interval status and disease were all entered into the logistic regression model, but some individual factors were missing.

Background

Readmission refers to an episode where an inpatient is readmitted for the same disease with 30 days.[1, 2] In most studies, readmission findings reflect that inpatient care did not meet patient requirements, with readmission rates used as an evaluation index for

hospitalisation quality.[3] Readmission usually occurs in the same hospital, but sometimes occurs across hospitals because of deterioration of a patient's disease.[4] However, in rural China, multilevel institutional readmission is a common and important healthcare utilisation. This reflects defects of China's healthcare delivery system, rather than hospitalisation quality, especially in township–county (TC) readmissions. TC readmission is a health-seeking behaviour in which inpatients seek healthcare services in a township hospital first, and then in a county hospital, whether planned or unplanned, voluntarily or passively. TC readmission is frequent in rural China, and currently accounts for approximately 2.0% of all inpatient services.[5] TC readmission usually occurs following doctor recommendation/referral or by individual patient choice.

TC readmission recommended by doctors occurs when a township doctor has an inpatient admission that they cannot fully treat or completely cure;[6] consequently, that patient is referred directly to a county hospital or advised to go to a county hospital for subsequent admission.[6] This situation results from the three-tier healthcare delivery system in rural China, where care is provided in a village–town–county healthcare delivery system, and all hospital services are supplied by township and county hospitals.[7] In general, the higher the level of the institution, the stronger the service capability, the greater the distance a patient must travel and the higher the medical cost. Township hospitals bear the responsibilities of transferring patients, taking care of inpatients with general illnesses and advising patients with severe diseases (that are beyond their capacity) to seek admission at county hospitals.[8] Township hospital doctors sometimes receive patients whose diseases are beyond their capacity to manage (e.g. because of their inaccurate judgment, or

deterioration of the disease), meaning TC readmission may be unavoidable.

TC readmission from individual choice may occur when patients who should be readmitted to township hospitals choose to be admitted to county hospitals for personal reasons.[9] Some readmissions are influenced by quality concerns with township hospitals, poor patient compliance on medicine and after-care or from a normal disease recurrence. However, patients often do not acknowledge the real readmission reason and transfer responsibility for readmission to the township hospital doctor (e.g. considering readmission as a result of failed treatment) and consequently decide to be readmitted to a county hospital. This situation often represents inappropriate readmission.[10]

From the patients' perspective, no order or limitation on patient choice exists. In addition, no general practitioners or consultants are available in rural China. Therefore, residents freely choose hospitals and service types, mainly depending on their judgment regarding their disease and understanding of hospitals. If a patient chooses a higher-level institution than necessary, they pay more; if they choose a lower-level institution than necessary they would be referred or readmitted. Therefore, the cost of an incorrect decision is borne by the patient. To guarantee patient interests regarding TC readmission, the three-tier healthcare delivery system requires different-level hospitals to cooperate in providing continuous healthcare services. However, in reality, communication among township and county professional providers is limited, and there is virtually no document sharing or interaction among providers across the three tiers.[11] County hospital doctors do not deliver continued care for readmitted patients because of income incentives and risk aversion, and patients readmitted to a county hospital usually receive new treatment.[12] Furthermore,

compared with patients admitted directly to county hospitals, readmitted patients spend more time, pay more costs and may even miss proper treatments. As a result, when subsequent illnesses occur and patients are unable to judge the severity of their illness, they tend to choose admission in a county hospital, taking excess economic risk to avoid delay. Some studies have defined TC readmission as failed treatment from the patients' perspective, and shown that the TC readmission experience can influence a patient's later choice of hospital.[13, 14] Inpatients may be more likely to seek care in county hospitals compared with township hospitals; a phenomenon that is already happening. The annual growth rate of inpatients in county hospitals from 2010 to 2016 was 6.75%, whereas that of township hospital inpatients was 0.63% in rural China.[15]

As noted, TC readmission from individual choice may be an inappropriate level of admission, and TC readmission recommended by doctors can also result in inappropriate level admission for subsequent hospitalisation. Inappropriate level admission means patients seek healthcare in a higher-level hospital than necessary. This may result from patients' intentional institution selection and distrust of the capability of township hospitals; such patients prefer to spend more money on healthcare to avoid the risk of needing referral. Inappropriate level admission is a major form of excess service demand,[12] and an important determinant of increasing health expenditure that leads to significant waste. In this context, identifying the forms and determinants of TC readmission will help to improve the New Rural Cooperative Medical System (NRCMS). This study focused on choices for hospital readmission after a first admission as an inpatient in a township hospital, and identified the determinants of choice for hospital readmission.

Methods

Study setting

Qianjiang District was designated as the sample area through cluster sampling. This is a typical rural area located in Chongqing, which is the largest municipality in southwest China. Qianjiang has a per capita GDP of $7,515 in 2016, which is below the average GDP in China. The resident population is 550,000 people; all residents are covered under the NRCMS, and are eligible to receive reimbursement for inpatient care. Qiangjiang District has two county hospitals and 30 township hospitals. The township hospitals are divided into four levels according to their scale and service quantity by Qianjiang Health Bureau (Fig. 1). First-level township hospitals are allocated more than 30 beds and may perform abdominal operations; these hospitals had more than 1,200 discharged patients in 2013. Second-level township hospitals cannot perform abdominal operations of the same scale as first-level township hospitals. Third-level township hospitals have fewer than 30 beds and around 600~1,200 discharged patients. All other township hospitals belong to the fourth level.

Data source

This study was based on the NRCMS inpatient database in Qianjiang District, which contains all inpatient data for the population. In this database, a case refers to a single hospitalisation in a county or township hospitals.

Data processing

We focused on individuals who had been discharged from participating hospitals. Readmission cases were identified as having the same diagnosis in subsequent hospitalisations between county and township hospitals or township hospitals and township hospitals within 30 days. Given our population-based retrospective design, we compared the differences between township–township readmitted inpatients (TT group) and TC readmitted inpatients (TC group). Samples were entered into MS Excel 2010, based on the NRCMS database from 1 January 2008 to 31 December 2013. First, cases that shared the same patient identifier and the same disease codes were sorted in chronological order. Second, we calculated the interval between admissions in two adjacent cases for the same inpatient for the same disease; if the interval between admissions was less than 31 days, the patient was marked as a readmission patient. For example, if the first admission occurred in a township hospital and the second occurred in county hospital, the two cases would be merged as one case and marked as a TC readmission, and the patient marked as TC patient. TT patients were identified in a similar manner. Finally, all TC and TT cases were extracted into a new database. As diagnosis of a disease may change among different doctors, in different institutions or at different times, we adjusted the original International

Classification of Diseases, tenth revision disease code into a broader code (e.g. chronic obstructive pulmonary disease was adjusted from J44.900 to J44), which may improve accuracy in identifying readmitted patients. After screening, there were 6,764 readmitted patients from 2008–2013 in the sample.

The main programming techniques included Microsoft Excel formulas (e.g. COUNTIF, SUMPRODUCT, LOOKUP and IF) and case processing technologies (e.g. split columns and removal of duplicates).

Sociological characteristics were collected to build a final database, including: gender; age; travel time from home to county hospital; first inpatient information including length of stay (LOS), expenses, disease category, capacity of the township hospital, interval between admissions and readmitted hospital choice.[16] The distance and travel time to the county hospital for all readmitted patients were captured individually by Google Maps. Because traffic conditions are different in different towns (e.g. national roads, provincial roads or county roads), both the distance and travel time were captured.

Data obtained and Statistical analysis

The characteristics of patients' choices for hospital readmission were compared using t-tests and chi-square tests in IBM SPSS Statistics 22.0. The treatment capacity of township hospitals and the travel time to a county hospital from different towns have differential impacts on the observed predictors. Therefore, we assumed that the obtained data indicated a hierarchical structure, and the 6,764 records could be aggregated by town level. The determinants of choice for hospital readmission were examined using multilevel binomial logistic regression analysis using MLwiN 2.30, which was developed by the

University of Bristol, UK.[17] Patients were identified as level 1 and town as level 2. The regression model was as follows.

$$\log it(\pi_{ij}) = \beta_{0j}\text{cons} + \beta_1\text{Admitted Year}_{ij} + \beta_2\text{Gender}_{ij} + \beta_3\text{Age}_{ij} + \beta_4\text{Distance}_{ij} + \beta_5\text{Time}_{ij} + \beta_6\text{Capacity}_{ij} + \beta_7 1^{st}\text{LOS}_{ij} + \beta_8 1^{st}\text{Expends}_{ij} + \beta_9\text{Interval}_{ij} + \text{More14}_{ij}$$

$$\beta_{0j} = \beta_0 + u_{0j}$$

$\boldsymbol{\beta_i}$ refers to the fixed effects parameter, and $\boldsymbol{u_{oj}}$ refers to the random effects of level 2.

Patient and Public Involvement

No patients or public were involved in this research.

Ethical approval

The study protocol conformed to the guidelines of the Ethics Committee of the Tongji Medical College of Huazhong University of Science and Technology. The protocol was registered in the Chinese Clinical Trial Registry (ChiCTR-OOR-14005563). Patient information was anonymised and de-identified before analysis.

Results

Choices for hospital readmission after a first township hospitalisation

Among 271,405 discharged admissions in 2008–2013, there were 6,764 readmissions after a first hospitalisation in a township hospital. The TT group accounted for 62.5% (4,225) of all readmissions and the TC group for 37.5% (2,539) (Table 1).The number of readmissions increased sharply, whereas the proportion of readmissions in the total inpatients averaging around 5%. The TC group increased from 1.66% in 2008 to 1.89% in 2013, with the annual growth rate of the TC group being 28.55%, which was higher than

that of the TT group (22.38%).

Table 1. Number of readmissions each year in Qianjiang district (2008–2013)

Year	All inpatients	Readmissions* n (%)	Choice for hospital readmission**		*P****
			TT group n (%)	TC group n (%)	
2008	21,823	524 (4.80)	342 (3.14)	182 (1.66)	<0.001
2009	34,240	1,076 (6.27)	724 (4.23)	352 (2.04)	
2010	35,866	942 (5.25)	608 (3.39)	334 (1.86)	
2011	50,616	1,260 (4.98)	797 (3.16)	463 (1.82)	
2012	61,467	1,384 (4.50)	815 (2.64)	569 (1.86)	
2013	67,392	1,578 (4.67)	939 (2.78)	639 (1.89)	
Total	271,405	6,764 (4.98)	4,225 (3.11)	2,539 (1.87)	

* Readmission refers to readmissions whose first admission was in a township hospital.

** One readmission includes two admissions.

*** Pearson's chi-square test.

Readmission varied among towns (Table 2). Chengnan town had the lowest overall readmission ratio (2.95%) and the lowest TT readmission ratio (1.52%) of the 30 towns. Heixi town had the lowest TC readmission ratio (1.30%), Shijia town had the highest TC readmission ratio (2.86%) and Jindong town had the highest TT readmission (5.49%) and overall readmission (6.96%) ratios.

Table 2. Number of readmissions Qianjiang district (2008–2013), by town

Town	All inpatients	Readmissions* n (%)	Choice for hospital readmission**		*P****
			TT group n (%)	TC group n (%)	
Chengnan	11,716	173 (2.95)	89 (1.52)	84 (1.43)	<0.001
Heixi	9,073	137 (3.02)	78 (1.72)	53 (1.30)	
Shaba	8,778	152 (3.20)	81 (1.58)	71 (1.62)	
~	~	~	~	~	
Shijia	8,605	223 (5.18)	100 (2.32)	123 (2.86)	
Jindong	6,007	209 (6.96)	165 (5.49)	44 (1.47)	
Total	271,405	6,764 (4.98)	4225 (3.11)	2539 (1.87)	

* Readmission refers to readmissions whose first admission was in a township hospital.

** One readmission includes two admissions.

*** Pearson's chi-square test.

Characteristics of readmitted patients between TT and TC groups

Table 3 shows the characteristics of readmitted patients from 2008–2013. Male patients accounted for 48.7% of the TC group, which was a higher rate than in the TT group (41.9%, $P < 0.001$). Readmission choices varied in different age groups ($P< 0.001$), with over half (57.9%) of patients in the TC group aged 40–59 years. The most common interval between admissions in the TC group was shorter than 3 days (61.1%), whereas that in the TT group was 16–30 days (50.6%, $P < 0.001$). The average interval between admissions in the TC group was lower than that in TT group (6.03 days vs. 14.95 days). Similar patterns were observed in the average LOS of first inpatient admissions (6.96 days vs. 9.23 days) and travel time to county hospital (59.73 minutes vs. 61.79 minutes). However, an opposite trend was observed in terms of expenses of first inpatient admission (¥831.35 vs. ¥791.01). The TC group mostly had respiratory (37.7%) and digestive diseases (20.3%). There were no significant differences in the distance to a county hospital and the township hospital capacity between the TT and TC groups.

Table 3. Distribution of characteristics of readmitted patients (*n* = 6,764)

Variable	All n (%)	Choice for hospital readmission		*P*
		TT group n (%)	TC group n (%)	
All	6,764	4,225 (62.5)	2539(37.5)	
Gender				<0.001*
Male	3,006 (44.4)	1769(41.9)	1237(48.7)	
Female	3,758(55.6)	2456(58.1)	1302(51.3)	
Age, years				
Mean (SD)	48.18 (0.27)	46.94(0.35)	50.25(0.43)	<0.001**
Less than 20	950 (22.0)	629(22.9)	321(20.5)	<0.001*
20–39	1,215 (28.2)	877(31.9)	338(21.6)	
40–59	2,045 (47.4)	1192(43.4)	853(54.4)	
More than 59	103 (2.4)	48(1.7)	55(3.5)	
Distance to CH (km)				

Mean (SD)	36.29 (0.27)	35.99(0.34)	36.78(0.42)	0.15**
Time to CH (min)				
Mean (SD)	60.51 (0.45)	59.73(0.57)	61.79(0.72)	0.03**
Capacity of TH				0.53*
1st level (Strong)	3,076 (45.5)	1918(45.4)	1158(45.6)	
2nd level (Better)	1,315 (19.4)	802(19)	513(20.2)	
3rd level (General)	9,35 (13.8)	591(14)	344(13.5)	
4th level (Weak)	1,438 (21.3)	914(21.6)	524(20.6)	
1st LOS (day)				
Mean (SD))	8.38 (0.12)	9.23(0.16)	6.96(0.16)	<0.001**
1st Expense (RMB)				
Mean (SD)	816.21 (7.94)	831.35(9.95)	791.01(13.14)	0.01**
2nd LOS (day)				
Mean (SD)	10.24 (0.13)	10.03(0.16)	10.58(0.22)	0.04**
2nd Expense (RMB)				
Mean (SD)	2215.49 (45.46)	862.99(12.77)	4466.09(104.99)	<0.001**
Interval between admissions (day)				
Mean (SD)	11.6 (0.12)	14.95(0.14)	6.03(0.17)	<0.001**
~3	2,133(31.5)	582(13.8)	1551(61.1)	<0.001*
3–7	761 (11.3)	517(12.2)	244(9.6)	
7–15	1,328 (19.6)	987(23.4)	341(13.4)	
16–31	2,542 (37.6)	2139(50.6)	403(15.9)	
Disease category				<0.001*
Cancer	178 (2.6)	109(2.6)	69(2.7)	
ENT disease	338 (5.0)	243(5.8)	95(3.7)	
Respiratory disease	2,673 (39.5)	1715(40.6)	958(37.7)	
Circulatory disease	450 (6.7)	224(5.3)	226(8.9)	
Digestive disease	984 (14.5)	469(11.1)	515(20.3)	
Urinary disease	269 (4.0)	89(2.1)	180(7.1)	
Haematological disorders	19 (0.2)	2(0.1)	17(0.7)	
Bones and muscles	425 (6.3)	218(5.2)	207(8.2)	
Obstetrics and gynaecology	1,213 (17.9)	1037(24.5)	176(6.9)	

* Pearson's chi-square test.

** ANOVA.

Determinants of choice for hospital readmission after township hospitalisation

The two-level logistic regression is illustrated by the level 2 variance of the zero model.

This was statistically significant ($\chi^2 = 63.524$, $P < 0.001$), with aggregation of information at the town level. The specific results of the explanatory variables to fit the two variance component model are shown in Table 4. The major determinants of the choice for hospital readmission after a first township hospitalisation were admission year, age, travel time to a county hospital, interval between admissions, first LOS and disease category. If other factors remained constant, patients in the group aged 40–59 years were more likely to be readmitted to a county hospital (odds ratio [*OR*] = 1.32). Other factors associated with TC readmission were a shorter travel time to county hospital, shorter LOS, shorter interval between admissions, urinary tract diseases (*OR* = 2.68) or first admission/readmission in a more recent year. The ratio of patients with obstetric or gynaecological diseases readmitted to a county hospital was much lower than that of patients with cancer (*OR* = 0.40).

Table 4. Multilevel logistic regression model for hospital readmission choice

	Parameter estimate	Standard error	χ^2	*P*	Adjusted OR
Fixed Part:					
Constant	−271.3	41.231	49.524	<0.001	
Admitted year*	0.136	0.027	47.934	<0.001	1.14
Gender(reference: female)					
Male	−0.003	0.066	0.003	0.955	1.00
Age (reference: less than 20)					
20–39	−0.062	0.123	0.250	0.617	0.94
40–59	0.294	0.111	6.870	0.008	1.32
More than 59	0.034	0.102	0.116	0.735	1.03
Travel time (min)	−0.023	0.013	17.468	<0.001	0.97
Capacity of TH**	−0.017	0.035	0.204	0.658	0.98
1st LOS (day)	−0.036	0.006	53.177	<0.001	0.96
1st Expends (RMB)	0.001	0.001	1.323	0.255	1.00
2nd LOS (day)	−0.002	0.003	0.213	0.644	0.99
Interval between admissions (day)	−0.110	0.004	895.49	<0.001	0.90
Disease category (reference: cancer)					

ENT	−0.406	0.263	2.462	0.131	0.67
Respiratory disease	−0.256	0.217	1.327	0.251	0.78
Circulatory disease	0.512	0.256	4.627	0.028	1.64
Digestive disease	0.553	0.227	6.217	0.013	1.74
Urinary disease	0.982	0.264	13.950	<0.001	2.68
Haematological disorders	2.310	0.853	7.641	0.004	10.03
Bones and muscles	0.245	0.242	1.066	0.301	1.28
Obstetrics and gynaecology	−0.947	0.238	15.874	<0.001	0.40
Else	−0.132	0.265	0.251	0.617	0.88
Random Part:					
Town variance	0.153	0.036	17.921	<0.001	—
Patient scale parameter	1	0.00	—	—	—

* TC shows a stable increase in recent years, so admitted year was included in the analysis by order of ranked data.

** Capacity of township hospital included in the analysis by order of ranked data.

Discussion

Choice for hospital readmission and aggregation

Readmission is common and unavoidable, and can often be attributed to technology and management problems.[18] TC readmission accounted for 1.89% of all hospitalisation cases in Qianjiang in 2013, showing steady growth from 2008 (1.66%). In the study period, TC readmission accounted for more than one-third of readmission cases that had a first inpatient admission in a township hospital, which is common in rural China. However, as mentioned, TC readmission (either through doctor referral/recommendation or the patient's choice) often reflects an inefficient use of health services for patients; TC readmission patients may experience disease delays or cost waste, which may result in patient dissatisfaction regarding the township hospital. A point that needs to be noted here is the uncertainty about whether TT patients had been readmitted to a county hospital three or more times, which has been reported as a real scenario.

The two-level logistic regression analysis showed a hierarchy in the inpatient data (town–patients). Patients' choice of hospital readmission was clustered at the town level. In other words, 6,764 readmitted patients were non-independent, and the choices for hospital readmission in same town tended to be approximated. The incidence differed in different towns, from 2.95% (Chengnan) to 6.96% (Jindong). The 30 towns in the study area also differed in terms of township hospital, social customs and geographic location. Different township hospitals also have different service concepts and medical capabilities, which might have affected patients' hospital readmission choice.

Determinants of choice for hospital readmission

Logistic regression analysis showed that patient gender, capacity of township hospital and first admission expenses did not have significant effects on the choice of hospital for readmission. Readmission choice was affected by age, travel time to a county hospital, interval between admissions, LOS in the first admission and disease category. Although the towns in which patients lived affected their choice of hospital for readmission, the capacity of township hospitals had no significant effects; therefore, the town-based effects could be speculatively attributed to social customs and geographic location, which is consistent with a previous study.[19] In other words, regardless of capacity of the township hospital, readmission is unavoidable and occurs under the same rate; in theory, TC readmission resulted from the doctors' assessment of their treatment ability, or deterioration of disease rather than the general hospital capacity.[20]

In general, patients were more likely to be readmitted to a county hospital if they were in

an older age group, found travel to a county hospital more convenient, had lower expenses, had a shorter interval between admissions or diseases that were harder to assess. The ratio of patients choosing to be readmitted to a county hospital increased with age, which may be a result of the increased attention to the cure rate among those of more advanced age. The OR for travel time to a county hospital was 0.97, indicating that patients made their choice based on convenience.[16, 19] The most obvious influencing factors were first LOS and the interval between admissions. These factors can be combined to discuss the difference in choice. The average first LOS in the TT group was 9.23 days, which is close to 9.7 days, the standard LOS in township hospitals in China.[15] Moreover, the average interval between admissions was 14.95 days. In the TC group, the average first LOS was 6.96 days and the interval between admissions was 6.03 days. A shorter first LOS (*OR* = 0.96) and a shorter the interval between admissions (*OR* = 0.90) was associated with a greater likelihood of choosing a county hospital. This disparity may be associated with the degree of urgency of the disease. Patients with diseases related to the urinary system (*OR* = 2.68) and haematological disorders (*OR* = 10.03) were more likely to choose a county hospital compared with patients with cancer, respiratory diseases and other disease types. This finding may be related to township doctor assessment regarding treatment ability. Diseases in the urinary system, cardiovascular system and haematological disorders cannot be controlled well in township hospitals, leading to a higher rate of inaccurate assessments and a higher probability of readmission to a county hospital.[21] Respiratory and digestive diseases (e.g. influenza, paediatric bronchial pneumonia and chronic obstructive pulmonary disease[22]) have a high incidence and recurrence rate and can be controlled in

township hospitals. However, these diseases often have failed treatment outcomes because of poor patient compliance on medicine and after-care.[23] Consequently, these patients may be more likely to choose county hospitals for readmission. Moreover, readmissions tended to move toward county hospitals as year increased (*OR* = 1.14), which implies an endogenous factor as affected the increase of inpatients in county hospitals in recent years.

Identifying forms of TC readmission

We could differentiate TC admission from TT admission by first LOS and interval between admissions. Intervals in TC patient admission showed a U-shaped distribution; 61.1% were readmitted to a county hospital within 3 days, and a small prevalence peak appeared in the group after more than 15 days. Correspondently, 50.1% of patients in the TT group had an interval between admissions of more than 15 days. Therefore, a considerable proportion of early readmissions might be referrals; patients readmitted after a short first LOS with a short interval may be assumed to have been referred by doctors. A long first LOS and long interval were more likely to indicate a TC caused by individual choice, meaning an inappropriate TC readmission. Longer first LOS means a complete treatment in township hospital, and longer interval indicates readmission may have been caused by poor compliance on medicine and after-care from patients themselves or a normal disease recurrence.Therefore, a combination of first LOS and interval may be an effective identification index; we used 1 week as the cut-off value (Table 3). TC readmissions based on a doctor's incorrect assessment accounted for approximately 70.7% of admissions (interval between admissions <7 days), and those caused by patients accounted for 29.3% (interval between admissions >7 days).

The sample county is a typical rural area, and this research is a population based study, so the results could present the TC phenomenon in all rural China.

Conclusions

Patients were more likely to choose a county hospital for readmission over time. TC readmission remains a common health service use in rural China, and may result in inappropriate patient flows. Differences in readmission choices were associated with age, travel time to county hospital, first LOS, interval between admissions and diseases; all of these factors are easy to identify. Combination of first LOS and interval between admissions could be an effective identification index for the forms of TC readmission.

Limitations

Our study has several limitations. Hospitalisation information, geographical factors, interval status and disease were all entered into the logistic regression model. However, some individual factors (e.g. economic status, education and preference) were not available. Moreover, influence on choice of hospitals may reflect an accumulated process, meaning that the more patients experience TC readmission, the more significant the influence would become. However, we only studied the influence of the first TC readmission in a single year. These limitations may bring instability to our study and need to be resolved in future studies.

Competing interests

The authors have declared that no competing interests exist.

Authors' contributions

Y.Z. and L.Z. participated in conception and design, and the analyses, and wrote the manuscript. Y-D.N. participated in data collection and performed the statistical analysis. L.Z. helped to draft the manuscript, reviewed the manuscript and made final changes. All authors have given their final approval of the version to be published.

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Disclosure

No past publication history, no past presentation history

Provenance and peer review

Not commissioned; externally peer reviewed.

Data sharing statement

The anonymized dataset is available through the email of the corresponding author.

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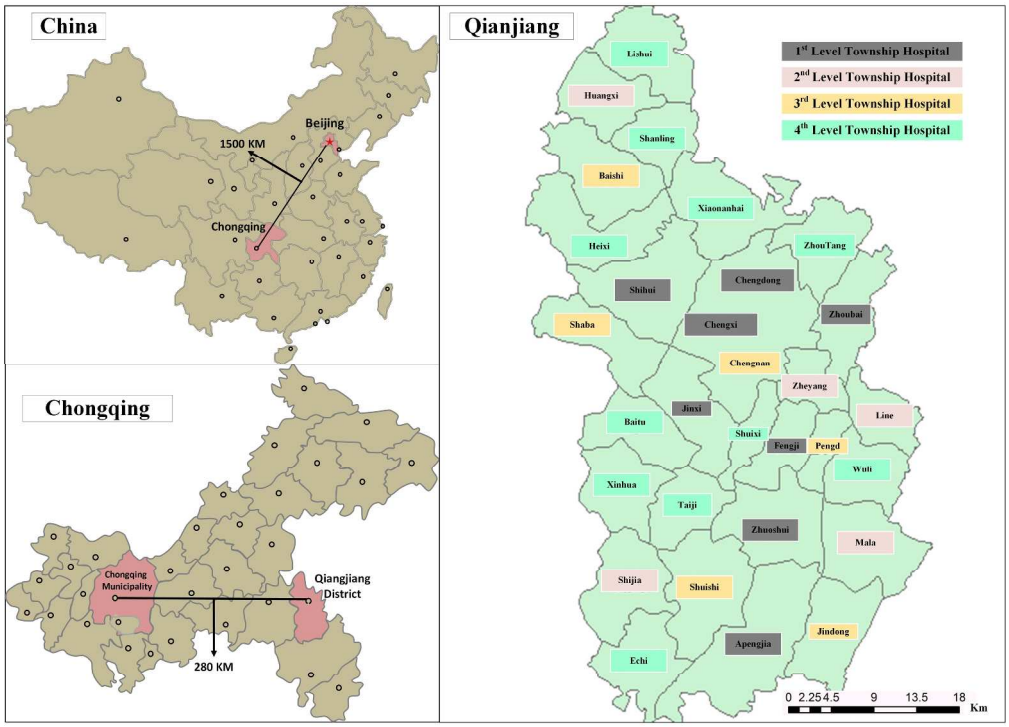
Figure Legend

Figure 1. Map of Qianjiang distract: geographic distribution



Map of Qianjiang distract: geographic distribution

136x113mm (600 x 600 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on Line #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	**Lines:1-2**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	**Lines:22-58**
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	**Lines:60-126**
Objectives	3	State specific objectives, including any prespecified hypotheses	**Lines:126-129**
Methods			
Study design	4	Present key elements of study design early in the paper	**Lines:152-154**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	**Lines:131-143**
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	**Lines:145-147**
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	**Lines:148-152**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	**Lines:152-166**
Bias	9	Describe any efforts to address potential sources of bias	**No**
Study size	10	Explain how the study size was arrived at	**Lines:167-168**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	**Lines:169-177**
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	**Lines:178-180**
		(*b*) Describe any methods used to examine subgroups and interactions	**Lines:180-190**
		(*c*) Explain how missing data were addressed	**No**
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	**No**
		(*e*) Describe any sensitivity analyses	**No**
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	**Lines:197-204**
		(b) Give reasons for non-participation at each stage	**No**
		(c) Consider use of a flow diagram	**No**
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	**Lines:218-234**
		(b) Indicate number of participants with missing data for each variable of interest	**No**
Outcome data	15*	Report numbers of outcome events or summary measures	**Lines:198-201**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	**Lines:235-250**
		(*b*) Report category boundaries when continuous variables were categorized	**Lines:235-250**
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	**No**
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	**Lines:209-217**
Discussion			
Key results	18	Summarise key results with reference to study objectives	**Lines:252-271; 332-338**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	**Lines:339-347**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	**Lines:272-328**
Generalisability	21	Discuss the generalisability (external validity) of the study results	**Lines:329-331**
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	**Lines:356-357**

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.