

Factors Associated With Hospitalization Costs of Coronary Heart Disease in Township Hospitals in Rural China

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Abstract

In large proportions of rural areas in many developing countries, health care delivery system is less developed and is less likely to be equipped to conduct sophisticated treatment for coronary heart disease (CHD) patients locally. This study aims at describing the status quo of and exploring factors associated with hospitalization costs of CHD in township hospitals where only drug therapy was available for CHD conditions. We collected data of inpatients with CHD from discharge records from 10 township hospitals in rural Liaoning from December 2013 to December 2014. We used multilevel linear regression to analyze the factors associated with CHD hospitalization costs. A total of 4635 inpatients were included in the analysis. We found that the average hospitalization costs were 6249.97 RMB (US\$1012.47) with the average of 8.89 days of hospitalization in township hospitals in Liaoning. Age, gender, length of stay, the number of times of admissions, by which route was hospitalized, and type of CHD were all the factors significantly associated with hospitalization costs of CHD in township hospitals. The factors associated with hospitalization costs of CHD in township hospitals in rural China showed some different features from the existing studies. When the government designs the related policy, the policy makers need to consider the specific feature of hospitalization costs of CHD in township hospitals in rural areas.

Keywords

coronary heart disease, hospitalization costs, township hospitals, rural, china

What do we already know about this topic?

The limited evidence on coronary heart disease costs in low- and middle-income countries mainly used samples from tier-3 hospitals in urban areas with a few based on samples from self-reported cases or samples from claims data.

How does your research contribute to the field?

This study described the status quo of and explored factors associated with hospitalization costs of coronary heart disease based on a sample specifically from township hospitals, the hospitals with the highest level of care in rural China.

What are your research's implications toward theory, practice, or policy?

Our findings provide policy makers with empirical evidences to design health policies related to coronary heart disease in rural areas where health care delivery system is less developed.

Introduction

Coronary heart disease (CHD) is the leading cause of death globally in the past 15 years, which accounted for 15.5% of all deaths worldwide in 2015.¹ In contrast to many high-income countries (HICs), CHD mortality has shown an increasing trend in most low- and middle-income countries (LMICs).² China, as the largest developing country worldwide, has witnessed the unprecedented increase of CHD mortality due to the drivers of economic growth, changing lifestyles, and population aging.³ Coronary heart disease has

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grown into the second leading cause of mortality in China.⁴ The rise of CHD mortality in China is largely driven by this increase in mortality in rural areas.⁵ In the last decades, CHD mortality increased by 9.2% and 7.0% per year for rural men and women, respectively, which were much higher than those in urban China.⁶ Given that treating CHD is quite costly, the rapid increase of disease burden caused by CHD in rural China, where more than 60% of the population live, has become a significant public health concern.

In large proportions of rural areas in many LMICs, health care delivery system is less developed and is less likely to be equipped to conduct sophisticated percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG) for CHD patients.^{7,8} Besides PCI and CABG, the other treatment option for CHD is drug therapy. In such places, drug therapy may be the only treatment that the facilities there could provide to CHD patients. Health resource allocation in the rural area requires cost evidence among patients who obtained treatment in the facilities there. However, studies on CHD costs specifically in rural areas in LMICs are very scant. The vast majority of the available evidence on CHD costs were based in HICs.⁹⁻¹³ The limited evidence on CHD costs in LMICs mainly used samples from tier-3 hospitals in urban areas¹⁴⁻¹⁷ with a few based on samples from self-reported cases^{18,19} or samples from claims data.^{20,21} This study is going to fill this gap in the literature by describing the status quo of and exploring factors associated with hospitalization costs of CHD based on a sample specifically from tier-2 township hospitals in Liaoning province.

Materials and Methods

The Study Setting and Data

We obtained ethical approval from the ethical committee of Dalian Medical University, China (Ethical Approval Code: DYGW2018L001). This study used data of all inpatients with principal diagnosis of CHD based on *ICD-10* (*International Classification of Diseases, Tenth Revision*) codes from discharge records from 10 township hospitals in rural Liaoning from December 2013 to December 2014. More specifically, this study did not include inpatients with secondary diagnosis of CHD. In addition, this study focused on the CHD among adults, so we excluded the inpatients with CHD aged less than 20 years. From December 2013 to December 2014, 4678 inpatients with CHD were admitted to the 10 township hospitals in Liaoning. After deleting those inpatients aged less than 20 years (27) and the observations with 0 or missing hospitalization costs (16), 4635 inpatients were included in the analysis (Supplemental Table S1).

Liaoning province locates in northeast China with a total of 14 cities and is one of the 3 old industrial bases in China. All the selected township hospitals in this province belong to tier-2 hospitals in China. These 10 township hospitals are

located in 7 cities in Liaoning with 2, 3, and 2 cities having the upper, middle, and lower economic development level in this province, respectively. Similar to other provinces in China, rural Chinese in Liaoning are free to choose any hospitals in urban or rural areas. However, if they choose hospitals outside the county they reside, the social health insurance targeted for the rural population will reimburse significantly less to them. So, township hospitals, the hospitals with the highest level of care in rural China (tier-3 hospitals are the highest level of hospitals and are all based in urban China) are the major hospitals for Chinese rural population to seek care. In the all 10 selected township hospitals, only drug therapy was available to treat CHD patients. So our sample only included those patients who used drug therapy as the treatment option in township hospitals.

Variables and Their Measurements

Table 1 presents a list of all variables that were included in this study. The outcome variable was defined as the sum of different expenses incurred during the hospitalization period, including consultation, nursing, laboratory tests, drugs, medical aids, disposables, and ward beds. We collected the hospitalization cost data from discharge records in the selected hospitals.

For explanatory variables, this study included demographic, basic information on hospitalization, and disease information variables. Demographic information included age and gender of the inpatient. Basic information on hospitalization included length of stay (LOS), the number of times of admissions, and by which route was hospitalized. Disease information included type of CHD and whether the inpatient had complications. Complications were identified in combination of *ICD-10* and the clinical doctors' judgment.

Statistical Analysis

We used mean and standard deviation to describe the characteristics of hospitalization costs overall and in subpopulations. We relied on Spearman rank correlation test to study the bivariate relationship between hospitalization costs and continuous explanatory variables in this study (eg, LOS) as well as Wilcoxon rank-sum test (for categorical variables with 2 categories) and Kruskal-Wallis test (for categorical variables with more than 2 categories) to examine differences in hospitalization costs in subpopulations defined by categorical variables. Furthermore, we used multilevel linear regression to analyze the factors associated with CHD hospitalization costs. Multilevel linear regression was chosen to adjust for clustering of data within the same township hospital. Furthermore, to check the robustness of the results of our multilevel linear regression, we then did a traditional linear regression which included 10 township hospitals as 9 dummy variables in the model. In this study, multilevel linear regression is expressed as follows:

Table 1. Variables and Their Measurements.

Variables	Measurement
Hospitalization costs	Continuous variable
Age	
≤50	Dummy variable = 1 if person's age is in this range
50-60	Dummy variable = 1 if person's age is in this range
60-70	Dummy variable = 1 if person's age is in this range
70-80	Dummy variable = 1 if person's age is in this range
>80	80 above was the default variable
Gender	Dummy variable = 1 if individual is female
Length of stay	Continuous variable
The number of times of admissions	Continuous variable
By which route was hospitalized	
Outpatient	Being hospitalized by outpatient was the default variable
Emergency	Dummy variable = 1 if individual is hospitalized by emergency
Transferred from other institutions/other	Dummy variable = 1 if individual is hospitalized by transferred from other institutions/other
Type of CHD	
Angina	Angina was the default variable
Myocardial infarction	Dummy variable = 1 if individual has myocardial infarction
Other	Dummy variable = 1 if individual has other type of CHD
Complications	Dummy variable = 1 if individual has complications

Note. CHD = coronary heart disease.

$$y_{ij} = \beta_0 + \beta_1 x_{1ij} + \dots + \beta_n x_{nij} + u_{0j} + \varepsilon_{ij},$$

where y_{ij} is the amount of hospitalization costs of the individual i from j township hospital. β_0 is the intercept. x_{nij} are the explanatory variables. β_n is the coefficients of x_{nij} . u_{0j} is the error term independent across township hospitals and ε_{ij} is the error term independent both across individuals and township hospitals and is also independent of u_{0j} .

Results

Among the 4635 inpatients with CHD, on average, the inpatient paid 6249.97 RMB (US\$1012.47) with 8.89 days in hospital for 1 admission. The mean age of the inpatients was 67.54 years and the lower and upper quartile of age were 60 years and 75 years, respectively. Among the 4635 inpatients, 2888 (62.31%) were woman, 3542 (76.42%) were the first time admitted to the township hospitals, and 1916 (41.34%) had one or more than one complications. Meanwhile, 39.06% and 27.41% of the inpatients were hospitalized by emergency and outpatient, respectively. Of all the inpatients, more than 30% were with angina, while more than 17% with myocardial infarction (Table 2).

Table 2 also presents the results of descriptive analysis. Length of stay was positively associated with hospitalization costs with the correlation coefficient being 0.6612, while the number of times of admissions was negatively associated with the outcome variable. In addition, gender, by which route was hospitalized, type of CHD, and complications were all significantly correlated with hospitalization costs.

Table 3 demonstrates the results of the multilevel linear regression. Likelihood-ratio test showed that the multilevel linear regression was significantly different from the general linear regression, which implied that our data clustered at township hospital level. The coefficients, standard errors, and P values in Table 3 were obtained after adjusting for such clustering. We found that LOS was positively correlated with hospitalization costs. Being woman and the number of times of admissions were negatively associated with hospitalization costs. Compared with those aged 80 years above, those aged 50 years and below and those between 50 and 60 had significantly higher hospitalization costs, while those aged in other groups (ie, aged 60-70, 70-80) showed no significantly different hospitalization costs of CHD. Compared with those who were hospitalized by outpatient, those by emergency had significantly lower hospitalization costs. Compared with those patients with angina, those with myocardial infarction had significantly higher costs, while those with other CHD had significantly lower costs. When comparing the results of multilevel linear regression and the results of traditional linear regression, one can see that both methods had similar results in terms of coefficient, standard error, and significance of the included factors (see the appendix).

Discussion

This study makes an important contribution to the available literature as it is one of the very few studies describing the status quo of and identifying high-cost subgroups with CHD

Table 2. Descriptive Statistics for the Variables (N = 4635).

Variable	Mean/median	SD	Spearman R ^a	P value ^b
Hospitalization costs (RMB)	6249.97/4856.76	6580.41	—	—
Length of stay (day)	8.89/8	4.68	0.6612	P < .001
The number of times of admissions	1.69/1	2.28	−0.0943	P < .001
Variable	N	%	Mean	P value ^c
Age				
≤50	321	6.93	6938.35	
50-60	884	19.07	6998.48	
60-70	1576	34.00	6022.61	
70-80	1253	27.03	6016.85	
>80	601	12.97	5863.54	.5811
Gender				
Male	1747	37.69	6980.60	
Female	2888	62.31	5808.00	P < .001
By which route was hospitalized				
Outpatient	1270	27.41	6852.05	
Emergency	1810	39.06	6335.02	
Transferred from other institutions/Other	1554	33.53	5659.77	.001
Type of CHD				
Angina	1401	30.23	5696.78	
Myocardial infarction	818	17.65	8712.70	
Other	2416	52.13	5736.93	.001
Complications				
Yes	1916	41.34	5734.23	
No	2719	58.66	6613.39	P < .001

Note. CHD = coronary heart disease.

^aSpearman rank correlation was used to explore the relationship between hospitalization costs and continuous explanatory variables.

^bP value is for Spearman rank correlation.

^cP value is for Wilcoxon rank-sum test and Kruskal-Wallis test, which were used to test the difference of hospitalization costs in subpopulations defined by categorical variables (gender, type of CHD, etc).

Table 3. Results of Multilevel Linear Regression (N = 4635).

	Coefficient	SE	P value
Age			
≤50	798.529*	411.152	.052
50-60	949.905***	314.518	.003
60-70	72.332	282.866	.798
70-80	235.314	291.081	.419
Gender	−936.595***	180.581	<.001
Length of stay	562.021***	18.893	<.001
The number of times of admissions	−233.862***	40.419	<.001
By which route was hospitalized			
Emergency	−736.687**	282.105	.009
Transferred from other institutions/other	−314.797	398.331	.429
Type of CHD			
Myocardial infarction	2487.846***	270.113	<.001
Other	−424.336*	242.118	.080
Complications	−199.854	220.778	.365
Intercept	2828.952***	681.590	<.001
Random effects			
δ _{u₀} (level 2)	1348.713***	340.466	<.001
δ _{e₀} (level 1)	5833.434***	60.658	<.001
−2 × log likelihood ratio	107.40		P < .001

Note. CHD = coronary heart disease.

*Significant at 10%. **Significant at 5%. ***Significant at 1%.

in township hospitals in rural areas in LMICs. We found that the average hospitalization costs were 6249.97 RMB (US\$1012.47) with the average of 8.89 days of hospitalization in township hospitals in Liaoning, China. This result was much lower than the estimates in a previous study relying on the sample from a tier-3 hospital in urban China finding that the average hospitalization costs of CHD were US\$6791.38 in 2015¹⁶ and a study based on cost data from the health insurance bureau in Shanghai showing that the average hospitalization costs of CHD were US\$2546.59 in 2012.²¹ Our estimate was also different from those that relied on samples from tier-3 hospitals in other LMICs indicating that surgery or medical intervention were the main source of hospitalization costs,^{14,15,17} while our result was similar to a study relying on self-reported cases in 1 province of China indicating that the average direct costs of CHD were US\$1156.2 in 2010. The difference of hospitalization costs of CHD between our estimate and the previous evidence was due to the different samples. Our sample was purely from tier-2 hospitals in rural China, while other samples were either purely or partially from tier-3 hospitals. On average, hospitalization costs in tier-3 hospitals in China are much higher than those in tier-2 hospitals. Nationwide, the average hospitalization costs in tier-3 hospitals in China were 12 136.5 RMB in 2014, while the average hospitalization costs in tier-2 hospitals were 5171.5 RMB in 2014,²² which was at the similar level to the hospitalization costs of CHD estimated in this study.

We also demonstrated that those aged 50 years and below and those aged 50 to 60 had significantly higher hospitalization costs than those aged 80 years above, while the hospitalization costs showed no difference between those aged 60 to 80 and those aged 80 years above. Our results were opposite to the previous studies showing that age was positively associated with hospitalization costs of CHD.^{16,18} However, our results were similar to the study done by Wang et al demonstrating that compared with those aged more than 75 years, hospitalization costs were much higher among those aged less than 45 years and those between 45 and 65 years.²¹ It needs to be noted that most of our inpatients were the elder population aged 60 years and above. So the association between age and hospitalization costs identified in this study was basically the association among the elder population. Usually, the older a person, the worse health status he or she has. So age was often proved to be positively associated with health care expenditures,²³⁻²⁵ as the 2 previous studies on CHD showed.^{16,18} Our different results can be still explained by the different sample used in this study. Our elder sample with CHD might not be critically ill so they chose township hospitals and used exclusively drugs to treat their conditions. The very critically ill inpatients with CHD in the study setting may directly go or be transferred to tier-3 hospitals where other treatment options of CHD are available. In addition, in line with previous studies on CHD,^{15,16,18,21} we also found that men spent more on hospitalization costs. This is

probably because more men smoke and drink and thus men have more serious cardiovascular disease than women.⁴

LOS was found to be significantly associated with hospitalization costs in township hospitals. This result was also similar to studies related to CHD^{16,26} and to other related diseases.^{27,28} This suggests that shortening LOS is the direct and important way to control hospitalization costs of CHD in township hospitals. Similar to the results in the previous study,¹⁶ we further found that the more times a person was admitted to the township hospital, the less hospitalization costs he or she spent. Considering the level of medical services in township hospitals, the inpatient with CHD may rely on township hospitals to monitor or maintain his or her health condition. As inpatients' conditions become stable, the hospitalization costs may decrease. In addition, for CHD patients who were not the first time hospitalized within a year, the results of some tests in the previous hospitalization could still be used in the next hospitalization. Therefore, such CHD patients might not do as much tests as new CHD patients and incur less hospitalization costs.

Another important finding is that inpatients with myocardial infarction had significantly higher hospitalization costs than those with angina. This result was in line with our expectation. Clinically, myocardial infarction is a much serious condition than angina. Our result could provide the policy makers with information on the gap of hospitalization costs between these 2 conditions in township hospitals and help them to make decisions on related policies, such as budget allocation for service expansion or payment standards of social health insurance in the rural area.

Interestingly, we showed that the inpatient with CHD hospitalized by outpatient had higher costs than those hospitalized by emergency. Usually, inpatients hospitalized by emergency were more likely to have more serious condition and thus pay higher hospitalization costs than those by outpatient. But we detected the opposite association between hospitalization route and its costs. In addition, in contrast with previous studies on CHD treated in tier-3 hospitals in urban areas,¹⁵⁻¹⁷ we did not find that complications was a significant factor influencing hospitalization costs. Our somehow 2 different results can also be both explained by the sample included in this study. Our results suggest the government that when designing the policy which needs the information on the factors on hospitalization costs on CHD in rural China, hospitalization route and complications may not be the 2 important factors to take into consideration.

A few limitations of this study need to be acknowledged. First, our study only used the sample from 10 township hospitals where only drug treatment option was available. So our results could not be generalized to other levels of hospitals nor other treatment options (ie, PCI and CABG). Second, the outcome variable in our study was hospitalization costs. We were intended to analyze out-of-pocket expenditure and specific components of hospitalization costs related to CHD. However, we found that data on

specific components of hospitalization costs were very incomplete in some of our selected township hospitals. For out-of-pocket expenditure data, the only social health insurance (New Cooperative Medical System) can only reimburse the inpatients after their treatment, that is, the inpatients need to pay all the hospitalization costs first to the hospitals by themselves and then apply the reimbursement of the social health insurance in rural China. That means township hospitals usually do not have the information on out-of-pocket expenditure. So we could only analyze total hospitalization costs. Further studies are needed to systematically study hospitalization costs of CHD in township hospitals. Third, as a retrospective study using second-hand data, similar to studies on cost analysis on CHD¹⁶ and other chronic disease,²⁹ information on income, education, and occupation was not included in our data.

Further prospective study is still needed as to thoroughly analyze the factors associated with hospitalization costs of CHD in the rural area.

Conclusions

Generally, the factors associated with hospitalization costs of CHD in township hospitals in rural China showed some different results from the existing studies based on other sources of samples. Such difference mainly depends on the level of hospitals and the available treatment option in different samples. When the government designs the related policy (such as budget allocation for service expansion or payment standards of social health insurance) in rural areas, the policy makers need to consider the specific feature of hospitalization costs of CHD in township hospitals.

Appendix

Results of Traditional Linear Regression (N = 4635).

	Coefficient	SE	P value
Age			
≤50	742.610*	401.350	.064
50-60	953.328***	314.207	.002
60-70	74.963	282.610	.791
70-80	241.142	290.739	.407
Gender	-935.199***	179.749	<.001
Length of stay	563.675***	18.871	<.001
The number of times of admissions	-239.030***	40.449	<.001
By which route was hospitalized			
Emergency	-706.893**	284.882	.013
Transferred from other institutions/other	-47.710	420.889	.910
Type of CHD			
Myocardial infarction	2501.207***	269.912	<.001
Other	-472.798*	244.067	.053
Complications	-173.519	222.346	.435
Township hospital (Hospital 1 was the default variable)			
Hospital 2	-2898.770***	530.718	<.001
Hospital 3	-1101.127	675.672	.103
Hospital 4	510.231	395.507	.197
Hospital 5	-1576.704***	541.772	.004
Hospital 6	-1271.248**	554.422	.022
Hospital 7	-1381.778	2398.185	.565
Hospital 8	1038.572**	425.212	.015
Hospital 9	2249.698***	384.803	<.001
Hospital 10	-1009.263**	438.178	.021
Intercept	3174.027***	560.752	<.001

Note. CHD = coronary heart disease.

*Significant at 10%. **Significant at 5%. ***Significant at 1%.

Declaration of Conflicting Interests

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Ethical Approval

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Supplemental Materials

Supplemental material for this article is available online.

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