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Complete List of Authors:	Lin, Xiaojun; Huazhong University of Science and Technology Tongji Medical College, Department of Health Administration, School of Medicine and Health Management Cai, Miao; Huazhong University of Science and Technology Tongji Medical College, Department of Health Administration, School of Medicine and Health Management; Saint Louis University, Department of Health Management and Policy, College for Public Health and Social Justice Tao, Hongbing; Huazhong University of Science and Technology, Department of Health Administration, School of Medicine and Health Management Liu, Echu; Saint Louis University, Department of Health Management and Policy, College for Public Health and Social Justice Cheng, Zhaohui; School of Medicine and Health Management, Tongji Medical College, Huazhong University of Science & Technology, Department of Health Administration Xu, Chang; Huazhong University of Science and Technology Tongji Medical College, School of Medicine and Health Management, Tongji Medical College Wang, Manli Xia, Shuxu; Huazhong University of Science and Technology Tongji Medical College, School of Medicine and Health Management, Tongji Medical College Jiang, Tianyu; Huazhong University of Science and Technology Tongji Medical College, School of Medicine and Health Management, Tongji Medical College

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Does insurance status matter? In-hospital mortality and length of stay of patients with different insurance status in Shanxi, China

Xiaojun Lin[1], Miao Cai[1,2], Hongbing Tao[1], Echu Liu[2], Zhaohui Cheng[1], Chang Xu[1], Manli Wang, Shuxu Xia[1], Tianyu Jiang[1]

Authors' affiliations:

[1] Department of Health Administration, School of Medicine and Health Management, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China

[2] Department of Health Management and Policy, College for Public Health and Social Justice, Saint Louis University, Saint Louis, MO, USA

Corresponding author: Hongbing Tao, School of Medicine and Health Management, Tongji Medical College, Huazhong University of Science and Technology. No. 13 Hangkong Rd., 430030, Wuhan, P.R. China

Tel: 0086-27-83692531, Fax: 0086 -27-83692727, E-mail: hhbtao@hust.edu.cn

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ABSTRACT

Objectives: To determine insurance-related disparities in hospital care for patients with acute myocardial infarction (AMI), heart failure(HF), and pneumonia.

Setting and participants: Using International Classification of Diseases, Tenth Revision (ICD-10) codes, a total of 22392 patients with acute myocardial infarction (AMI), 8056 patients with heart failure (HF), and 17161 patients with pneumonia were selected from 31 tertiary hospitals in Shanxi, China from 2014 to 2015. Patients were stratified by health insurance status: Urban Employee-based Basic Medical Insurance (UEBMI), Urban Resident-based Basic Medical Insurance (URBMI), New Cooperative Medical Scheme (NCMS), and Self-payment.

Outcome measures: In-hospital mortality and length of stay (LOS).

Results: The highest unadjusted in-hospital mortality rate was detected in the NCMS patients independent of medical conditions (4.7%, 4.4%, and 11.1% for AMI, HF, and pneumonia, respectively). The lowest unadjusted in-hospital mortality rate and the longest LOS were observed in the UEBMI patients. After controlling patient- and hospital-level covariates, compared with UEBMI, the adjusted in-hospital mortality was significantly higher for NCMS and Self-payment among AMI patients, significantly higher for NCMS among HF patients, and significantly higher for URBMI, NCMS and Self-payment among pneumonia patients. Length of stay (LOS) of the URBMI, NCMS, and Self-payment group was significantly shorter than that of the UEBMI group.

Conclusions: Insurance-related disparities in hospital care for patients with 3

common medical conditions were observed in this study. NCMS patients had significantly higher adjusted in-hospital mortality and shorter LOS compared with UEBMI patients. Policies on minimizing the disparities among different insurance schemes should be established by the government.

Strengths and limitations of this study

- This a comprehensive study to explore the association between health insurance status and health outcome in Shanxi province, China， revealing the disparities among four insurance groups regrading adjusted in-hospital mortality and length of stay, for consideration for policymakers.
- This study is based on a broad population comprising patients with acute myocardial infarction, heart failure and pneumonia.
- Owing to the limitations of using an administrative database, we are unable to capture all potential confounders in our study, especially the socioeconomic information of patients.
- Patients in other levels of hospitals in Shanxi province, China were not included in this study.

INTRODUCTION

The Chinese government launched its new nationwide health care reform in 2009 to provide affordable and equitable access to healthcare.[1] With advancements in this reform, the Chinese government has shown remarkable political will and commitment to universal health coverage.[2] From 2009 to 2011, the government spent an additional 850 billion Chinese Yuan (about 230 billion USD) for the reform, and allocated about half of this funding for subsidizing the premiums of the New Cooperative Medical Scheme (NCMS) and the Urban Resident-based Basic Medical Insurance (URBMI).[3] In 2012, three social health insurance (SHI) schemes in China, namely, the Urban Employee-based Basic Medical Insurance (UEBMI), URBMI, and NCMS covered more than 95% of the Chinese population.[4] This advancement was lauded as an "unparalleled" achievement.[5] However, those three insurance schemes differ substantially in target population, administration, source of funding, funding level, and benefit packages,[1, 6] which pose a threat on equities in health outcomes.[7]

Several studies have explored the disparities in health outcomes among different insurance status in developed countries.[8-11] However, few studies have explored the similar topics in developing countries, especially in China, the most populous country in the world and one of the fastest developing entity. Several studies in China focused on the effects of implementing individual SHI schemes on health outcome,[12, 13] resource utilization,[14, 15] and financial risk,[16, 17] while recently researchers have shifted their focus on disparities in health outcome across different health insurance groups, specifically among patients with myocardial infarction,[18, 19] peritoneal dialysis,[20] intracranial hemorrhage,[21] and schizophrenia.[22] However, previous studies in China revealed ambiguous results and provided empirical evidence merely at single hospital level or municipal level. To our knowledge, no study has examined the disparities in health outcome among different insurance groups on a large scale in China.

China is transforming from developing country to a developed entity and huge disparities exist between urban and rural people. Empirical evidence on the disparities of health outcomes among different insurance groups in China could improve the understanding of health disparities in both the developed and under-developed world. Therefore, to fill in the gap in the literature, this study proposes to explore the disparities among four insurance groups regrading adjusted in-hospital mortality and length of stay. We hypothesized that the adjusted in-hospital mortality and length of stay of patients hospitalized with AMI, HF, and pneumonia are associated with health insurance status.

METHODS

Data source

A retrospective study was conducted using data from 31 tertiary hospitals in Shanxi, China. Brief electronic health records were extracted from the administrative database, which contains over 200 variables, including patients' sociodemographic characteristics (e.g., age, gender, race/ethnicity, occupation, and insurance status), principal discharge, secondary diagnosis, procedures, LOS, and discharge status.

Patients

Using *International Classification of Diseases, Tenth Revision* (ICD-10) codes, we identified all patients with AMI (ICD-10 codes: I21), HF (ICD-10 code: I50), and pneumonia (ICD-10 code: J10-J18) between January 1, 2014 and December 31, 2015. Patient in UEBMI, URBMI, NCMS, and Self-payment group were selected for further analyses. We excluded patients under 18 years and over 90 years and patients who were discharged alive within 1 day after admission. We also excluded patients who were transferred to another hospital or community health service centers and patients with missing health insurance data and discharge disposition. All patient records were anonymous and de-identified before analysis was conducted.

Study variables

In-hospital mortality and LOS were selected as the measures of health outcomes during hospitalization, respectively. In-hospital mortality was defined as all deaths that occurred during hospital stay, and LOS was defined as the period from the day of admission to the day of hospital discharge.

Patients were stratified into four groups according to health insurance status: UEBMI, URBMI, NCMS, and self-payment. To assess the association of health insurance status, health outcomes (adjusted in-hospital mortality and LOS), we selected patient- and hospital-level covariates on the basis of previous studies.[9, 10, 23, 24] Patient-level covariates included age, gender, admission source, admission condition, and comorbid disease. The four categories for admission source were as follows: outpatient medical services, emergency medical services, referral, and other sources. The conditions for admission, which is set as a proxy of disease severity,[25] were classified into three groups: emergency, urgent, and regular condition. Comorbidities were identified from secondary diagnosis, and Charlson comorbidity index was considered to assess the effect of comorbid diseases or disorders.[26, 27] The 31 selected tertiary hospitals in this study were teaching hospitals and owned by the government. Therefore, we included the following hospital-level covariates: hospital volume, number of hospital beds, number of nurses per 100 beds, number of doctors per 100 beds, and hospital region. Hospital volume was defined as the total inpatients who were treated at hospitals using annual condition-specific volume averaged over the 2-year period. For the purposes of characterizing the sample, hospitals were categorized into two groups according to the median of hospital volume. The hospital region was classified into three groups: south, north, and middle areas.

Statistical analysis

Patient- and hospital-level covariates and unadjusted outcomes were compared through ANOVA or Kruskal–Wallis test for continuous variables and either Pearson χ^2 analysis or Fisher exact test for categorical variables as appropriate.

Considering the clustering of patients within hospitals,[28] we used multilevel mixed-effect logistic regression models to estimate the adjusted effects of health insurance status on in-hospital mortality. Multicollinearity was determined by using variance inflation factors. The statistical significance of the association between health insurance status and in-hospital mortality was assessed via Wald χ^2 test. The area under the receiver operating characteristic curve (AUC) was used to assess statistical model discrimination. Hosmer–Lemeshow test was conducted to evaluate the statistical significance of differences in the calibration of each model among deciles of the observed and predicted risks. The sensitivity analyses for each model were also performed to validate model performance and discrimination. Each model was re-estimated after the most statistically significant covariate was removed as measured by Wald statistic. The potential for spurious results is reduced if the originally observed effect is not substantially attenuated (<10%) and still statistically significant after re-estimation is conducted.[29]

In view of the problems of overdispersion in the model and the clustered effect of patients within the same hospital, we constructed the multilevel mixed-effect negative binomial regression mode to estimate the effects of health insurance status on LOS.[30] The results from this model are in the form of log ratios between the variable and the reference group, which is known as the incidence rate ratio (IRR).

Categorical variables are presented as percentages and continuous variables as means ± standard deviation. The odds ratios (OR) with a 95% confidence interval (CI) and IRRs with a 95% CI are reported as the results of logistic regression models and negative binomial regression models, respectively. P values are two tailed. $P < 0.05$ was considered statistically significant. All analyses were performed in R software version 3.2.2 and Stata version 14.0 (Stata Crop, College Station, TX).

RESULTS

Patient and hospital characteristics

We identified 22392 patients for AMI, 8056 patients for HF, and 17161 patients for pneumonia in this study. The frequencies of patient and hospital characteristics stratified on the basis of health insurance status are listed in Table 1. Patients with UEBMI (39%) and NCMS (43%) represented the largest health insurance group for AMI, HF (UEBMI: 40%, NCMS: 42%), and pneumonia (UEBMI: 50%, NCMS: 32%). Male was the most common characteristic in all of the health insurance groups. Under each condition, the patients in the NCMS group were younger and more likely to be admitted under emergent conditions when they had AMI (34%) and HF (21%) than the patients in the UEBMI group ($P<0.001$). For patients with AMI, 50% of them were admitted through outpatient medical services, and 48% were through emergency medical services. Meanwhile, this pattern of hospitalization was similar in HF (77% and 21%, respectively) and pneumonia (69% and 22%, respectively). Under each condition, the Charlson comorbidity index of the patients with NCMS was lower than that of the UEBMI patients ($P<0.001$). A majority of the patients in the Self-payment group also received health care in hospitals with high beds, and a large proportion of patients sought health care in hospitals located in the middle area of Shanxi.

Table 1. Patient and hospital characteristics, according to medical condition and condition-specific health insurance status.

Variable	Acute Myocardial Infarction						Heart Failure						Pneumonia					
	All patients	Insurance Status					All patients	Insurance Status					All patients	Insurance Status				
		UEBMI	URBMI	NCMS	Self-payment	*P*		UEBMI	URBMI	NCMS	Self-payment	*P*		UEBMI	URBMI	NCMS	Self-payment	*P*
Patient characteristics																		
No. of Patients(%)	22392(100.0)	8664(38.7)	1494(6.7)	9656(43.1)	2578(11.5)		8056(100.0)	3239(40.2)	721(9.0)	3395(42.1)	701(8.7)		17161(100.0)	8540(49.8)	1273(7.4)	5459(31.8)	1889(11.0)	
Age — year	61.3±12.6	63.0±12.8	63.7±13.3	59.6±11.8	60±13.2	<0.001	67.5±13.1	69.9±12.2	69.3±13.5	65.0±12.9	66.6±15.3	<0.001	64.3±16.7	66.8±15.5	65.1±19.2	61.0±16.1	62.0±19.4	<0.001
Female (%)	5614(25.1)	1439(16.6)	709(47.5)	2821(29.2)	645(25.0)	<0.001	3794(47.1)	1038(32.0)	514(71.3)	1888(55.6)	354(50.5)	<0.001	6811(39.7)	2648(31.0)	824(64.7)	2511(46.0)	828(43.8)	<0.001
Admission source(%)						<0.001						<0.001						<0.001
Outpatient medical services	11207(50.0)	4151(47.9)	655(43.8)	5123(53.1)	1278(49.6)		6221(77.2）	2507(77.4)	530(73.5)	2709(79.8)	475(67.8)		118318(68.9)	5854(68.5)	844(66.3)	3999(73.3)	1134(60.0)	
Emergency medical services	10664(47.6)	4277(49.4)	811(54.3)	4331(44.9)	1245(48.3)		1695(21.0）	659(20.3)	185(25.7)	635(18.7)	216(30.8)		3849(22.4)	1966(23.0)	338(26.6)	1050(19.2)	495(26.2)	
Referral	245(1.1)	84(1.0)	11(0.7)	123(1.3)	27(1.0)		15(0.2)	5(0.2)	1(0.1)	7(0.2)	2(0.3)		1119(6.5)	502(5.9)	72(5.7)	338(6.2)	207(11.0)	
Others	276(1.2)	152(1.8)	17(1.1)	79(0.8)	28(1.1)		125(1.6）	68(2.1)	5(0.7)	44(1.3)	8(1.1)		362(2.1)	218(2.6)	19(1.5)	72(1.3)	53(2.8)	
Admission condition(%)						<0.001						<0.001						<0.001
Regular	11337(50.6)	4279(49.4)	747(50.0)	4971(51.5)	1340(52)		6124(76.0)	2490(76.9)	549(76.1)	2556(75.3)	529(75.5)		13658(79.6)	6785(79.5)	1012(79.5)	4388(80.4)	1473(78.0)	
Emergency	6682(29.8)	2492(28.8)	421(28.2)	3266(33.8)	503(19.5)		1474(18.3)	538(16.6)	124(17.2)	702(20.7)	110(15.7)		2255(13.1)	1138(13.3)	166(13.0)	724(13.3)	227(12.0)	
Urgent	4373(19.5)	1893(21.8)	326(21.8)	1419(14.7)	735(28.5)		458(5.7)	211(6.5)	48(6.7)	137(4.0)	62(8.8)		1248(7.3)	617(7.2)	95(7.5)	347(6.4)	189(10.0)	
Charlson Comorbidity Index	3.9±1.9	4.2±1.9	4.4±2.0	3.7±1.7	3.6±1.9	<0.001	4.8±1.9	5.2±1.9	4.9±1.9	4.5±1.8	4.9±2.2	<0.001	3.9±2.2	4.2±2.2	4.0±2.3	3.5±2.1	3.7±2.5	<0.001
Hospital characteristics																		
Hospital beds	1145.4±363.8	1155.3±355.3	1087.5±332.8	1123.8±383.6	1226.4±315.3	<0.001	1032.8±325.4	1077.9±312.3	1019.3±310.9	969.4±332.1	1145.1±302.1	<0.001	1199.7±382.3	1227.6±368.4	1163.1±378.8	1129.7±413.6	1300.2±308.2	<0.001
Number of nurses per 100 beds	65.9±13.0	64.2±12.8	63.4±12.8	68.1±64.9	64.9±12.2	<0.001	35.1±15.0	36.2±14.8	37.1±14.9	33.9±15.4	33.4±12.7	<0.001	32.8±11.5	33.2±11.2	34.4±11.6	32.3±12.5	31.6±9.9	<0.001
Number of doctors per 100 beds	41.8±7.9	41.5±7.9	42.1±7.6	42.5±8.1	40.2±6.7	<0.001	36.8±9.0	37.2±8.6	37.4±10.1	36.5±9.1	36.1±8.6	<0.001	36.1±8.7	36.5±8.3	36.3±9.4	35.4±9.1	36.4±8.6	<0.001
Hospital volume (%）						<0.001						<0.001						<0.001
Below median	11823(52.8)	4956(57.2)	977(65.4)	4978(51.6)	912(35.4)		4054(50.3)	1755(54.2)	375(52.0)	1657(48.8)	267(38.1)		8466(49.3)	3560(41.7)	687(54.0)	3519(64.5)	700(37.1)	
Above median	10569(47.2)	3708(42.8)	517(34.6)	4678(48.4)	1666(64.6)		4002(49.7)	1484(45.8)	346(48.0)	1738(51.2)	434(61.9)		8695(50.7)	4980(58.3)	586(46.0)	1940(35.5)	1189(62.9)	
Hospital region (%)						<0.001						<0.001						<0.001
North	3770(16.8)	1533(17.7)	216(14.5)	1231(12.7)	790(30.6)		1768(22.0)	861(26.6)	133(18.4)	462(13.6)	312(44.5)		3084(18.0)	1530(17.9)	163(12.8)	716(13.1)	675(35.7)	
South	8839(39.5)	2645(30.5)	500(33.5)	4999(51.8)	695(27.0)		2774(34.4)	818(25.2)	221(30.7)	1577(46.5)	158(22.5)		4446(25.9)	1587(18.6)	323(25.4)	2177(39.9)	359(19.0)	
Middle	9783(43.7)	4486(51.8)	778(52.1)	3426(35.5)	1093(42.4)		3514(43.6)	1560(48.2)	367(50.9)	1356(39.9)	231(33.0)		9631(56.1)	5423(63.5)	787(61.8)	2566(47.0)	855(45.3)	

UEBMI, the urban employee-based basic medical insurance; URBMI, urban resident-based basic medical insurance scheme; NCMS, the rural new cooperative medical scheme.

Plus-minus values are means ± standard deviation. Percentages may not total 100 because of rounding.

Unadjusted outcomes

The unadjusted outcomes of the health insurance groups are presented in Table 2. The overall in-hospital mortality rates for AMI, HF, and pneumonia were 4.0%, 3.4%, and 7.7%, respectively. In-hospital mortality following pneumonia was highest for NCMS (11.1%) and URBMI (9.1%) patients. Under each condition, the NCMS patients incurred the highest unadjusted in-hospital mortality (4.7%, 4.4%, and 11.1% for AMI, HF, and pneumonia, respectively) among all health insurance groups (P<0.001), while UEBMI patients yielded the lowest unadjusted in-hospital mortality (3.1%, 2.4%, and 5.7% for AMI, HF, and pneumonia, respectively) (P<0.001).

The mean LOS for AMI, HF, and pneumonia were 11.7±6.6 days, 10.5±6.2 days, and 13.0±9.4 days, respectively. Under each condition, the patients in the UEBMI group conferred the longest unadjusted mean LOS (12.5±7.8 days, 11.6±6.3 days, and 13.9±9.9 days for AMI, HF, and pneumonia, respectively) among all the health insurance groups followed by URBMI group.

Table 2. Unadjusted outcomes for all patients with acute myocardial infarction, heart failure, and pneumonia by health insurance status.

Outcome	UEBMI	URBMI	NCMS	Self-payment	*P*
Acute Myocardial Infarction					
In-hospital mortality	3.1%	4.4%	4.7%	4.2%	<0.001
Length of stay (days)	12.5±7.8	12.1±6.1	11.2±5.6	10.6±6.0	<0.001
Heart Failure					
In-hospital mortality	2.4%	2.8%	4.4%	3.9%	<0.001
Length of stay (days)	11.6±6.3	10.3±5.5	9.6±6.1	10.0±6.3	<0.001
Pneumonia					
In-hospital mortality	5.7%	9.1%	11.1%	5.7%	<0.001
Length of stay (days)	13.9±9.9	13.1±9.5	11.9±8.0	11.9±10.5	<0.001

UEBMI, the urban employee-based basic medical insurance; URBMI, urban resident-based basic medical insurance scheme; NCMS, the rural new cooperative medical scheme.

Adjusted outcomes for the effect of health insurance status

Table 3 shows the results of multilevel multivariable analyses of the relationship between health insurance status and in-hospital mortality and LOS after patient- and hospital-level covariates were controlled.

Table 3. Adjusted outcomes for the effect of health insurance status among patients with acute myocardial infraction, heart failure, and pneumonia.

Outcome	UEBMI	URBMI	NCMS	Self-payment	AUC
Acute Myocardial Infarction					
In-hospital mortality	1.0	1.22 (0.91-1.63)	1.39 (1.17-1.66)***	1.69 (1.31-2.20)***	0.80
Length of stay(days)	1.0	0.96 (0.93-0.98)***	0.90 (0.89-0.92)***	0.85 (0.83-0.87)***	-
Heart Failure					
In-hospital mortality	1.0	1.31 (0.76-2.27)	1.93 (1.37-2.74)***	1.38 (0.84-2.27)	0.82
Length of stay(days)	1.0	0.90 (0.87-0.94)***	0.85 (0.82-0.87)***	0.87 (0.84-0.91)***	-
Pneumonia					
In-hospital mortality	1.0	1.64 (1.29-2.10)***	1.97 (1.69-2.30)***	1.48 (1.17-1.87)***	0.83
Length of stay(days)	1.0	0.95 (0.92-0.99)***	0.87 (0.85-0.89)***	0.88 (0.85-0.90)***	-

UEBMI, the urban employee-based basic medical insurance; URBMI, urban resident-based basic medical insurance scheme; NCMS, the rural new cooperative medical scheme; AUC, area under receiver operator curve.

*P<0.1, ** P<0.05, *** P<0.01. In-hospital mortality reported as adjusted odds ratio (95% confidence interval). Length of stay reported as incidence rate ratio (95% confidence interval). Reference group: UEBMI. Outcomes adjusted for patient age, gender, health insurance status, admission source, admission condition, Charlson comorbidity index, hospital volume, number of hospital beds (per increases 100 beds), number of nurses per 100 beds, number of doctors per 100 beds, and hospital geographic region.

Compared with the UEBMI patients, adjusted in-hospital mortality among AMI patients was significantly higher for NCMS (adjusted odds ratio (OR) 1.39, 95% CI=1.17-1.66) and Self-payment (OR=1.69, 95% CI= 1.31-2.20), and among HF patients was significantly higher for NCMS (OR=1.93, 95% CI=1.37-2.74), and among pneumonia patients was significantly higher for URBMI (OR=1.64, 95% CI= 1.29-2.10), NCMS (OR=1.97, 95% CI= 1.69-2.30) and Self-payment (OR=1.48, 95% CI= 1.17-1.87). In additional, the results of multilevel mixed-effect negative binomial regression models similarly demonstrated that the LOS of URBMI, NCMS, and

Self-payment groups under each condition was significantly shorter than that of the UEBMI group (P<0.001). For example, after the patient and hospital characteristics were adjusted in the cases of AMI, our model suggested that the patients in NCMS stayed approximately 90% of the time in the hospital compared with the patients in UEBMI.

The sensitivity analysis results for in-hospital mortality are shown in Table 4. The reported associations between health insurance status and risk-adjusted in-hospital mortality were not significantly attenuated after re-estimation, which suggested that the estimated effect of health insurance status was unlikely influenced by adjustment for potentially unmeasured confounders.

Table 4. Sensitivity analysis for in-hospital mortality.

		OR in Original Model	OR in Re-estimated Model	Percentage of Attenuation
Acute Myocardial Infarction	URBMI	1.22	1.20	1.2%
	NCMS	1.39	1.38	1.0%
	Self-payment	1.69	1.69	0.2%
Heart Failure	URBMI	1.31	1.27	3.5%
	NCMS	1.93	1.88	2.9%
	Self-payment	1.38	1.38	0.0%
Pneumonia	URBMI	1.64	1.67	1.9%
	NCMS	1.97	1.97	0.1%
	Self-payment	1.48	1.45	2.1%

OR, odds ratio; UEBMI, the urban employee-based basic medical insurance; URBMI, urban resident-based basic medical insurance scheme; NCMS, the rural new cooperative medical scheme; AUC, area under receiver operator curve.

Each original model was re-estimated after removing the most statistically significant covariate as measured by Wald statistic. The reference group in each model was UEBMI group. The percentage of attenuation of OR was calculated. The potential for spurious results is reduced if the originally observed effect is not substantially attenuated (<10%) and still statistically significant after re-estimation is conducted.

DISCUSSION

This study found that health insurance status is associated with in-hospital mortality and LOS of patients who were hospitalized for AMI, HF, and pneumonia in Shanxi, China, even after controlling for patient- and hospital-level covariates. Our results remain consistent across patients with different diagnosis and models with different covariates. Patients with NCMS have significantly higher unadjusted and risk-adjusted in-hospital morality in all 3 conditions than patients with UEBMI. The patients in the URBMI group yielded poorer adjusted in-hospital mortality in the case of pneumonia, and the patients in the Self-payment group exhibited an increase in the risk of adjusted in-hospital mortality for AMI and pneumonia. In addition, our results also demonstrate that health insurance status was statistically associated with LOS. Patients with UEBMI had the longest LOS among all insurance groups. In all, our findings suggest that there are insurance-related differences in health outcomes in the Chinese context.

The impact of health insurance status on health outcomes in China has been a recent focus of research. In a study exploring the association between medical insurances and clinical outcomes for patients with ST-elevation myocardial infarction in Shanghai, Liu *et al*[18] found that the cardiac mortality of patients with NCMS was higher than that of patients with other insurance types, and insurance status was associated with major adverse event-free survival rates. Before the health care reform was established in 2009, Yu[19] found that clinical treatments, length of stay (LOS), and medical expenditure of the patients with acute myocardial infarction (AMI) are associated with insurance status; insured patients utilize more healthcare resources and receive more efficient health outcomes than uninsured patients do. Wang *et al*[20] performed a single-center study and demonstrated that the survival of NCMS patients in 5 years is lower than that of UEBMI patients following peritoneal dialysis. These findings of previous studies are consistent with our results in this study. Our study expanded upon the limited literature on insurance-related disparities in China in several aspects. First, a broad population comprising patients with AMI, HF, and pneumonia was included in our study and thus helped us examine the effects of health insurance status on health outcomes under diverse medical conditions within a large population. Second, the hospital data we used in this work were within 2014–2015, which could reflect the situation several years later since China launched its new health care reform in 2009. Third, given the cluster effects, we applied the multilevel mixed-effect logistic regression model and the multilevel mixed-effect negative binomial regression model to quantify the effects of health insurance status on in-hospital mortality and LOS, respectively. Thus, these models could provide a more exact estimation than conventional logistic regression and linear regression model.

In view of the disparities across health insurance groups, a key question emerges: why are there disparities in health outcomes across health insurance groups?

One possible explanation is the wide gap in benefit coverage across insurance schemes. As reported by the World Health Organization, the SHI schemes in China varies largely in the following dimensions: breath (percentage of population covered), depth (percentage of health costs covered), and scope (type of health services covered).[31] NCMS covered more population than the UEBMI, but it was inferior in terms of depth and scope. The premiums for UEBMI are much higher than those of either URBMI or NCMS,[1] and UEBMI provides more comprehensive benefit packages than URBMI and NCMS do.[32, 33] NCMS participants possess fewer funds, smaller service coverage, and lower reimbursement level than the URBMI and UEBMI patients do.[34-36] In 2011, the reimbursement rate of inpatient care for NCMS was 44%, while it was 68% for UEBMI participants.[4] The large differences in reimbursement level may influence their choice of treatments and time to surgery. Thus, these differences have an influence on health outcomes. For instance, dual anti-platelet therapy (DAPT) is an important therapy for ST-elevation myocardial infarction patients and may result in different outcomes. Liu *et al*[37] found that the DAPT adherence was lower in the NCMS group than that in other health insurance groups because of lower reimbursement level. Furthermore, NCMS patients experience treatment delay partly because of medical costs.

Another possible explanation is the gap in financial protections. The financial protection of UEBMI and URBMI is higher than that of NCMS because of greater financing capacity,[1, 17, 38] which may have an effect on LOS in health care. An investigation conducted in Zhejiang and Gansu reported that people with UEBMI and URBMI were more likely to seek for both inpatient and outpatient care than those with NCMS and with no insurance.[20] In a study conducted by Ma in 2010,[39] medical insurance predicted the LOS of cerebral infarction, and patients in the medical insurance with higher financial supports might be prone to prolong LOS although more treatments were not required. Health providers may be vigilant regarding new and expensive treatment forms and even provide different treatments for patients with the same condition but with different insurance status.[40] Patients with higher levels of payments may be given higher priority to receive health care services.[41] Other possible explanations, such as the experience of physicians, differences in procedures, education level, and lifestyle, accounting for the differences in health insurance status have been suggested by relevant studies,[8, 42, 43] but empirical evidence in China remains insufficient.

Since the SHI schemes was criticized for its fragmentation, calls for the consolidation of SHI schemes toward an equitable and efficient system have increased in recent years,[7, 44, 45] but the progress of the consolidation is slow. Several provinces or municipalities have piloted the consolidation of these schemes and some evidence showed that the consolidation contributed to the equitable access to health care and efficiency of the system.[7] In early 2016, the State Council of People's Republic of China promulgated a guideline on the integration of the URBMI and the NCMS, aiming to create a unified basic health insurance system. The URBMI and NCMS would be unified in six areas: insurance coverage, insurance finance, payment standard, medicine and medical service item catalog, management of the qualified insurance institutions, and insurance accounting.[46] This policy guideline has promoted the consolidation of SHI schemes in China, which provides an alternative way to narrow the gaps between different insurance programs and improve health equity. However, the consolidation may take a long process considering the lack of specific matching plans or policies, difficulty in merging administrative institutions and staff, unifying funding level and benefit packages, reforming payment systems, and strengthening information systems.[7, 40]

Policy implications

China's health care reform launched in 2009 has been improved in terms of the expansion of health insurance coverage. However, our findings suggested that further research and policy should focus more on the potential impact of health insurance status on the disparities of health outcomes in health care. Given these disparities, policies and quality improvement efforts, such as consolidating SHI schemes, reforming insurance reimbursement policies, should be performed to minimize these disparities. Policy makers should encourage inventive explorations under the guidelines of the government and conduct an appropriate policy adjustment and assessment to enhance consolidation.

Limitations

This study has several limitations. First, although our study suggested the association between health insurance status and health outcomes, it is not a causal relation. Second, our analysis was restricted to three common medical conditions in tertiary hospitals in Shanxi. The results may not be generalized to other diagnoses or patients in other levels of hospitals in China. Finally, a potential for unmeasured confounders was observed in our risk adjustment analysis and thus may cause inadequate risk adjustment. We are unable to capture all potential confounders in our study, especially the socioeconomic information of patients, because of the limitations of using an administrative database.

Further research

The observed disparities in our study reveal the potential influence of insurance status on health outcomes in inpatient service practices in China. However, the underlying mechanisms of the association between insurance status and health outcomes are complicated. Further research is necessary to explore the underlying mechanisms of this relationship and validate this relationship under other diagnoses, such as cardiovascular surgery, orthopedic surgery, and tumor therapy.

CONCLUSIONS

Health insurance status is associated with the health outcomes of patients who were hospitalized for AMI, HF, and pneumonia in Shanxi, China. In particular, the adjusted in-hospital mortality rate of NCMS patients was significantly higher and their LOS was shorter than those of UEBMI patients. Further research should be conducted to understand the mechanisms of the effects of health insurance status on health outcomes to support policy formulation and implementation. Policies also should be considered and formulated by the government to minimize the gaps across different insurance schemes and further improve the equity of health care delivery in China.

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REFERENCES

1. Yip WC, Hsiao WC, Chen W, *et al*. Early appraisal of China's huge and complex health-care reforms. *Lancet* 2012;379:833-42.
2. Tang S, Brixi H, Bekedam H. Advancing universal coverage of healthcare in China: translating political will into policy and practice. *Int J Health Plann Manage* 2014;29:160-74.
3. Yip W, Hsiao WC. What drove the cycles of Chinese health system reforms? *Health Systems & Reform* 2015;1:52-61.
4. Meng Q, Xu L, Zhang Y. Trends in access to health services and financial protection in China between 2003 and 2011: a cross-sectional study. *Lancet* 2012;379:805-14.
5. Liang L, Langenbrunner J. *The long march to universal coverage: lessons from China*. Washington, DC: World Bank 2013:5.
6. Dong K. Medical insurance system evolution in China. *China Econ Rev* 2009;20:591-7.
7. Meng Q, Fang H, Liu X, *et al*. Consolidating the social health insurance schemes in China: towards an equitable and efficient health system. *Lancet* 2015;386:1484-92.
8. Canto JG, Rogers WJ, French WJ, *et al*. Payer status and the utilization of hospital resources in acute myocardial infarction: a report from the National Registry of Myocardial Infarction 2. *Arch Intern Med* 2000;160:817-23.
9. LaPar DJ, Bhamidipati CM, Mery CM, *et al*. Primary payer status affects

mortality for major surgical operations. *Ann Surg* 2010;252:544-51.

10. Spencer CS, Gaskin DJ, Roberts ET. The quality of care delivered to patients within the same hospital varies by insurance type. *Health Affair* 2013;32:1731-9.
11. Spencer CS, Roberts ET, Gaskin DJ. Differences in the Rates of Patient Safety Events by Payer Implications for Providers and Policymakers. *Med Care* 2015;53:524-9.
12. Chen Y, Jin GZ. Does health insurance coverage lead to better health and educational outcomes? Evidence from rural China. *J Health Econ* 2012;31:1-14.
13. Cheng LG, Liu H, Zhang Y, *et al*. The impact of health insurance on health outcomes and spending of the elderly: evidence from china's new cooperative medical scheme. *Health Econ* 2015;24:672-91.
14. Li X, Zhang W. The impacts of health insurance on health care utilization among the older people in China. *Soc Sci Med* 2013;85:59-65.
15. Zhou Z, Zhu L, Zhou Z, *et al*. The effects of China's urban basic medical insurance schemes on the equity of health service utilisation: evidence from Shaanxi Province. *Int J Equity Health* 2014;13:23.
16. Hou Z, Van de Poel E, Van Doorslaer E, *et al*. Effects of NCMS on access to care and financial protection in China. *Health Econ* 2014;23:917-34.
17. Liu K, Wu QB, Liu JQ. Examining the association between social health insurance participation and patients' out-of-pocket payments in China: The role of institutional arrangement. *Soc Sci Med* 2014;113:95-103.
18. Liu B, Yan H, Guo R, *et al*. The basic social medical insurance is associated with

clinical outcomes in the patients with st-elevation myocardial infarction: a retrospective study from Shanghai, China. *Int J Med Sci* 2014;11:905-17.

19. Yu B. Influences of health insurance status on clinical treatments and outcomes for 4,714 patients after acute myocardial infarction in 14 Chinese general hospitals. *J Med Dent Sci* 2005;52:143-51.
20. Wang Z, Zhang Y, Xiong F, *et al*. Association between medical insurance type and survival in patients undergoing peritoneal dialysis. *BMC Nephrol* 2015;16:33.
21. Kong Y, Wang Y, Zhang JH, *et al*. Disparities in medical expenditure and outcomes among patients with intracranial hemorrhage associated with different insurance statuses in southwestern China. *Acta Neurochir Suppl* 2011;111:337-41.
22. Feng Y, Xiong X, Xue Q, *et al*. The impact of medical insurance policies on the hospitalization services utilization of people with schizophrenia: A case study in Changsha, China. *Pak J Med Sci* 2013;29:793-8.
23. Hasan O, Orav EJ, Hicks LS. Insurance status and hospital care for myocardial infarction, stroke, and pneumonia. *J Hosp Med* 2010;5:452-9.
24. Kim J, Lee SG, Lee K, *et al*. Impact of health insurance status changes on healthcare utilisation patterns: a longitudinal cohort study in South Korea. *BMJ Open* 2016;6:e9538.
25. Xu Y, Liu Y, Shu T, *et al*. Variations in the quality of care at large public hospitals in Beijing, China: a condition-based outcome approach. *PLoS One* 2015;10:e138948.

26. Charlson ME, Pompei P, Ales KL, *et al*. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 1987;40:373-83.

27. Quan HD, Sundararajan V, Halfon P, *et al*. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care* 2005;43:1130-9.

28. Rice N, Leyland A. Multilevel models: applications to health data. *J Health Serv Res Policy* 1996;1:154-64.

29. Lin DY, Psaty BM, Kronmal RA. Assessing the sensitivity of regression results to unmeasured confounders in observational studies. *Biometrics* 1998;54:948-63.

30. Carter EM, Potts HW. Predicting length of stay from an electronic patient record system: a primary total knee replacement example. *BMC Med Inform Decis Mak* 2014;14:26.

31. World Health Organization. Sustainable health financing, universal coverage and social health insurance. World Health Assembly Resolution, 2005, 58.

32. National Health and Family Planning Commission of the People's Republic of China. *2015 China Statistical Yearbook for Health and Family Planning*. Beijing: China Union Medical University Press, 2015.

33. Pan J, Lei X, Liu GG. Health Insurance and Health Status: Exploring the Causal Effect from a Policy Intervention. *Health Econ* 2016;25:1389-402.

34. Fu R, Wang Y, Bao H, *et al*. Trend of urban-rural disparities in hospital admissions and medical expenditure in China from 2003 to 2011. *PLoS One*

2014;9:e1085719.

35. Wagstaff A, Lindelow M, Jun G, *et al*. Extending health insurance to the rural population: an impact evaluation of China's new cooperative medical scheme. *J Health Econ* 2009;28:1-19.

36. Barber SL, Yao L. Development and status of health insurance systems in China. *The Int J Health Plann Manage* 2011;26:339-56.

37. Liu X, Wong H, Liu K. Outcome-based health equity across different social health insurance schemes for the elderly in China. *BMC Health Serv Res* 2015;16:9.

38. Yu H. Universal health insurance coverage for 1.3 billion people: What accounts for China's success? *Health Policy* 2015;119:1145-52.

39. Ma Y, Liu Y, Fu HM, *et al*. Evaluation of admission characteristics, hospital length of stay and costs for cerebral infarction in a medium-sized city in China. *Eur J Neurol* 2010;17:1270-6.

40. He AJ, Wu S. Towards universal health coverage via social health insurance in China: Systemic fragmentation, reform imperatives, and policy alternatives. *Appl Health Econ Health Policy* 2016:1-10.

41. Zhong H. Effect of patient reimbursement method on health-care utilization: evidence from China. *Health Econ* 2011;20:1312-29.

42. Mainous AGI, Diaz VA, Everett CJ, *et al*. Impact of insurance and hospital ownership on hospital length of stay among patients with ambulatory care–sensitive conditions. *Ann Fam Med* 2011;9:489-95.

43. Lantz PM, House JS, Lepkowski JM, *et al*. Socioeconomic factors, health behaviors, and mortality: results from a nationally representative prospective study of US adults. *JAMA* 1998;279:1703-8.

44. Wang H, Liu Z, Zhang Y, *et al*. Integration of current identity-based district-varied health insurance schemes in China: implications and challenges. *Front Med* 2012;6:79-84.

45. Wang X, Zheng A, He X, *et al*. Integration of rural and urban healthcare insurance schemes in China: an empirical research. *BMC Health Serv Res* 2014;14:142.

46. State Council of People's Republic of China. Guideline for integration of basic medical insurance for urban employees and the new rural cooperative medical scheme. 2016. http://www.gov.cn/zhengce/content/2016-01/12/content_10582.htm. (accessed 22 Sep 2016).

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	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	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	7
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-8
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	*6-7*
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	8-9
		(*e*) Describe any sensitivity analyses	9

Continued on next page

Results			Page
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	9-10
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
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	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	*10,12*
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	12-14
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	14
Discussion			
Key results	18	Summarise key results with reference to study objectives	15
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	19-20
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15-19
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.

Does insurance status matter? In-hospital mortality and length of stay of patients with different insurance status in Shanxi, China

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Complete List of Authors:	Lin, Xiaojun; Huazhong University of Science and Technology Tongji Medical College, Department of Health Administration, School of Medicine and Health Management Cai, Miao; Huazhong University of Science and Technology Tongji Medical College, Department of Health Administration, School of Medicine and Health Management; Saint Louis University, Department of Health Management and Policy, College for Public Health and Social Justice Tao, Hongbing; Huazhong University of Science and Technology, Department of Health Administration, School of Medicine and Health Management Liu, Echu; Saint Louis University, Department of Health Management and Policy, College for Public Health and Social Justice Cheng, Zhaohui; School of Medicine and Health Management, Tongji Medical College, Huazhong University of Science & Technology, Department of Health Administration Xu, Chang; Huazhong University of Science and Technology Tongji Medical College, School of Medicine and Health Management, Tongji Medical College Wang, Manli Xia, Shuxu; Huazhong University of Science and Technology Tongji Medical College, School of Medicine and Health Management, Tongji Medical College Jiang, Tianyu; Huazhong University of Science and Technology Tongji Medical College, School of Medicine and Health Management, Tongji Medical College

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Does insurance status matters? In-hospital mortality and length of stay of patients with different insurance status in Shanxi, China

Xiaojun Lin[1], Miao Cai[1,2], Hongbing Tao[1], Echu Liu[2], Zhaohui Cheng[1], Chang Xu[1], Manli Wang[1], Shuxu Xia[1], Tianyu Jiang[1]

Authors' affiliations:

[1] Department of Health Administration, School of Medicine and Health Management, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China

[2] Department of Health Management and Policy, College for Public Health and Social Justice, Saint Louis University, Saint Louis, MO, USA

Corresponding author: Hongbing Tao, School of Medicine and Health Management, Tongji Medical College, Huazhong University of Science and Technology. No. 13 Hangkong Rd., 430030, Wuhan, P.R. China

Tel: 0086-27-83692531, Fax: 0086 -27-83692727, E-mail: hhbtao@hust.edu.cn

Keywords: insurance status, mortality, length of stay, acute myocardial infarction, heart failure, pneumonia, cross-sectional

Word count: 4201

ABSTRACT

Objectives: To determine insurance-related disparities in hospital care for patients with acute myocardial infarction (AMI), heart failure(HF), and pneumonia.

Setting and participants: Using International Classification of Diseases, Tenth Revision (ICD-10) codes, a total of 22392 patients with AMI, 8056 patients with HF, and 17161 patients with pneumonia were selected from 31 tertiary hospitals in Shanxi, China from 2014 to 2015. Patients were stratified by health insurance status: Urban Employee-based Basic Medical Insurance (UEBMI), Urban Resident-based Basic Medical Insurance (URBMI), New Cooperative Medical Scheme (NCMS), and Self-payment.

Outcome measures: In-hospital mortality and length of stay (LOS).

Results: The highest unadjusted in-hospital mortality rate was detected in the NCMS patients independent of medical conditions (4.7%, 4.4%, and 11.1% for AMI, HF, and pneumonia, respectively). The lowest unadjusted in-hospital mortality rate and the longest LOS were observed in the UEBMI patients. After controlling patient- and hospital-level covariates, compared with UEBMI, the adjusted in-hospital mortality was significantly higher for NCMS and Self-payment among AMI patients, significantly higher for NCMS among HF patients, and significantly higher for URBMI, NCMS and Self-payment among pneumonia patients. LOS of the URBMI, NCMS, and Self-payment group was significantly shorter than that of the UEBMI group.

Conclusions: Insurance-related disparities in hospital care for patients with 3

common medical conditions were observed in this study. NCMS patients had significantly higher adjusted in-hospital mortality and shorter LOS compared with UEBMI patients. Policies on minimizing the disparities among different insurance schemes should be established by the government.

Strengths and limitations of this study

- This a comprehensive study to explore the association between health insurance status and health outcome in Shanxi province, China， revealing the disparities among four insurance groups regrading adjusted in-hospital mortality and length of stay, for consideration for policymakers.
- This study is based on a broad population comprising patients with acute myocardial infarction, heart failure and pneumonia.
- Owing to the limitations of using an administrative database, we are unable to capture all potential confounders in our study, especially the socioeconomic information of patients.
- Patients in other levels of hospitals in Shanxi province, China were not included in this study.

INTRODUCTION

The Chinese government launched its new nationwide health care reform in 2009 to provide affordable and equitable access to healthcare.[1] With advancements in this reform, the Chinese government has shown remarkable political will and commitment to universal health coverage.[2] The current Chinese social health insurance (SHI) system consists of the Urban Employee-based Basic Medical Insurance (UEBMI), the Urban Resident-based Basic Medical Insurance (URBMI) and the New Cooperative Medical Scheme (NCMS). The coverage of SHI rose from 29.7 % in 2003 to more than 95% of the Chinese population in 2011,[3] and this advancement was lauded as an "unparalleled" achievement.[4]

However, these three insurance schemes differ substantially in target population, administration, source of funding, funding level, and benefit packages.[1, 5] Specifically, the UEBMI (initiated in 1994 and launched in 1998) is a mandatary program targeting at urban employees and retired employees.[4] In 2014, 283 million urban employees were rolled in the UEBMI.[6] The annual premium of the UEBMI (8% of the payroll) is shared between employers and employees, while employers pay 6% as tax and employees pay 2%. The per-capita fund of UEBMI is about six and seven times higher than other two insurance programs, reaching around 2840.6 yuan in 2014.[6] The UEBMI provides the most comprehensive coverage, including both inpatient and outpatient care services, with the inpatient reimbursement rate of about 80% in 2014. Unlike the UEBMI, URBMI (initiated in 2007 and formally launched in 2009) is a voluntary program, aiming at covering urban residents who were not covered by the

UEBMI. By the end of 2014, 314.5 million urban residents have participated in the URBMI.[6] Its premium was highly subsidized by the government, while individuals contribute a small proportion. The per-capita fund of URBMI was 524.4 yuan in 2014.[7] The reimbursement rate for inpatient care and outpatient care increased with time and reached 70% and 50% in 2014, respectively.[8] Both UEBMI and URBMI funds were pooled at prefecture/municipality level and administrated by the Ministry of Human Resource and Social Security. Initiated in 2003 and formally launched in 2006, the NCMS is also a voluntary program, aiming to cover rural residents. By 2014, the NCMS has covered 736 million rural residents, accounting for 98.9% of the rural population.[8] Similar to the URBMI, the government subsidies are the major funding sources of the NCMS, while the participants pay for a small proportion. The NCMS covered primarily inpatient care and some outpatient services for selected chronic conditions, and its reimbursement rate for inpatient care and outpatient care reached 75% and 50% in 2014, respectively. NCMS was pooled at county level and managed by the Chinese National Health and Family Planning Commission. In China, type of registration (rural or urban) and employment status, rather than self-selection, are major determinants of insurance scheme enrollment.[9]

In China's recent health care reform, universal health coverage has improved the accessibility to health care services, but this does not guarantee the equality in health outcome and health care utilization of individuals enrolled in different insurance schemes. Recently, a few studies in China have explored the disparities in health outcome and health care utilization across different health insurance groups, specifically among patients with acute myocardial infarction (AMI),[10, 11] peritoneal dialysis,[12] intracranial hemorrhage,[13] and schizophrenia.[14] In 2005, Yu[10] analyzed medical records of 4714 patients with AMI and found that insurance status was not associated with in-hospital mortality significantly, while uninsured AMI patients were less likely to receive interventions and medications, and had a shorter length of stay (LOS). However, in a study exploring the association between medical insurances and clinical outcomes for patients with ST-elevation myocardial infarction in Shanghai, Liu *et al*[11] found that the incidence of major adverse events and cardiac mortality of patients with NCMS were higher than those of patients with other insurance types. Wang *et al*[12] performed a single-center study and demonstrated that the survival rate of NCMS patients in 5 years is lower than that of UEBMI patients with peritoneal dialysis. Kong *et al*[13] compared the differences of in-hospital mortality and LOS by insurance types, and they found that patients locally insured had higher death rate and longer LOS than both nonlocally insured patients and uninsured patients, but risk adjustment was not conducted in their study. Feng *et al*[14] explored the impact of medical insurance policies on the hospitalization service utilization of patients with schizophrenia and revealed that patients with UEBMI were admitted in high-level medical institutions and received costly medications. Fang *et al*[15] indicated that UEBMI respondents were more likely to receive preventive health care services than NCMS respondents. Using the data of the National Survey of the Aged Population in Urban/Rural China in 2006 and 2010, Liu *et al*[9] found that UEBMI participants achieved better self-reported health status, physical functions, and psychological well-being than URBMI, NCMS, and uninsured participants did.

Previous studies have indicated that there are insurance-related disparities in health outcomes and health care utilization in several diseases or specific populations, but it remains unknown that whether this relationship persists in a wider population or other diseases. Moreover, the risk adjustment and the nest or cluster effects (patients treated at the same hospital experience similar outcomes) were ignored in previous studies in China, which may result in biased estimations and provide wrong evidence for in the policy formulation process.

To fill in the gap in the literature, this study proposes to explore the disparities among three SHI groups and self-payment group (patients who pay the cost of care without reimbursement) regarding adjusted in-hospital mortality and length of stay. The primary reason why we choose AMI, heart failure (HF) and pneumonia is that they are common conditions in China. Further, we can compare our results with previous studies that analyzed patients with AMI. We used a large administrative database in Shanxi to examine this important question. Because previous studies suggest that both NCMS and URBMI has lower funding level and more limited benefit packages than UEBMI, and that NCMS participants have worse outcomes and utilize less health care services,[9, 11, 12] we hypothesized that NCMS and URBMI patients hospitalized with AMI, HF, and pneumonia have higher adjusted in-hospital mortality and shorter LOS than that of UEBMI patients.

METHODS

Data source

Shanxi province is located in the northern of China. It has 36.5 million residents, with 53.79% living in urban areas in 2014.[16] According to the statistics of the National Health and Family Planning Commission, there were 37 tertiary hospitals in Shanxi in 2014 and 2015, but the data in 6 tertiary hospitals were unavailable for the study team. Therefore, we only included 31 tertiary hospitals in Shanxi in this study.

Using administrative data from hospital electronic health records (EHRs), we conducted a retrospective study of patients hospitalized between January 1, 2014 and December 31, 2015. The data contains over 200 variables, including patients' sociodemographic characteristics (e.g., age, gender, race/ethnicity, occupation, and insurance status), diagnosis codes (principal diagnosis code, up to 10 secondary diagnosis codes), up to 7 procedure codes, total costs, service charges in sub-categories, LOS, and outcomes (discharge status, medical adverse events during the hospitalization). The EHRs in those hospitals follow a national template and have adopted standardized disease coding in International Classification of Diseases, Tenth Revision (ICD-10). The EHRs from various hospitals in Shanxi were entered by qualified coders who have received professional coding training and were certified by the Medical Record Management Association of the Chinese Hospital Association. In addition, the study team randomly sampled 10% of the EHRs to validate the accuracy of variables, such as patients' demographic characteristics, insurance type, principal and secondary diagnosis codes, and LOS, and the overall variable accuracy reaching about 97%. All patient, medical staff and hospital identifiers, such as name, ID card number, address, postcode, and insurance number, were excluded before the data were provided to the study team.

Patients

Using ICD-10 codes with variations in the 3 digits after the decimal point, we identified all patients with the principal diagnosis of AMI (ICD-10 codes: I21.x), HF (ICD-10 codes: I50.x), and pneumonia (ICD-10 codes: J10.x-J18.x) between January 1, 2014 and December 31, 2015 (see supplemental table 1). We chose the three diseases as the subject of this study for the following reasons. Cardiovascular disease (CVD) remains the leading cause of death in China, with the mortality rate of 42.5% in urban areas and 44.6% in rural areas attributed to CVD.[17] AMI and HF have been two common causes for hospitalization in China.[18, 19] It is estimated that there were 290 million patients with CVD in 2014, and one in five Chinese adults suffered from CVD. Among individuals with CVD, 2.5 million had a myocardial infarction and 4.5 million had a heart failure.[20] Similarly, pneumonia is one of the leading causes of death in adults and children in China,[21] and it is estimated that there are 2.5 million people with pneumonia annually and that 5% of them die of pneumonia-related disease.[22]

Patient in UEBMI, URBMI, NCMS, and Self-payment group were selected for further analyses. As shown in figure 1, we excluded patients under 18 years and over 90 years and patients with missing health insurance data and discharge disposition. We also excluded patients who were transferred to another hospital or community health service centers because their admissions were truncated and the subsequent treatment information in other facilities was also unavailable for our study. We further excluded patients who were discharged alive within 1 day after admission because they were likely to leave against medical advice and the treatment time was very limited.

Study variables

In-hospital mortality and LOS were selected as the measures of health outcomes during hospitalization, respectively. In-hospital mortality was defined as all deaths that occurred during hospital stay, and LOS was defined as the period from the day of admission to the day of hospital discharge.

The core independent variable was health insurance status, including UEBMI, URBMI and NCMS, as well as self-payment. Since previous studies suggest that patients with UEBMI have better outcomes and utilize more health care resource than other insurance types,[9, 11, 12] UEBMI was selected as the reference group in this study. To assess the association of health insurance status, health outcomes (adjusted in-hospital mortality and LOS), we selected patient- and hospital-level covariates on the basis of previous studies.[23-26] Patient-level covariates included age, gender, admission source, admission condition, and comorbid disease. The four categories for admission source were as follows: outpatient medical services, emergency medical services, referral, and other sources. The conditions for admission, which is set as a proxy of disease severity,[27] were classified into three groups: emergency, urgent, and regular condition. Comorbidities were identified from secondary diagnosis, and Charlson comorbidity index was considered to assess the effect of comorbid diseases or disorders.[28, 29] The 31 selected tertiary hospitals in this study were teaching hospitals and owned by the government. Therefore, we included the following hospital-level covariates: hospital volume, number of hospital beds, number of nurses per 100 beds, number of doctors per 100 beds, and hospital region. Hospital volume was defined as the total inpatients who were treated at hospitals using annual condition-specific volume averaged over the 2-year period. For the purposes of characterizing the sample, hospitals were categorized into two groups according to the median of hospital volume. The hospital region was classified into three groups: south, north, and middle areas.

Statistical analysis

Patient- and hospital-level covariates and unadjusted outcomes were compared through ANOVA or Kruskal–Wallis test for continuous variables and either Pearson χ^2 analysis or Fisher exact test for categorical variables as appropriate.

Considering the clustering of patients within hospitals,[30] we used multilevel mixed-effect logistic regression models to estimate the adjusted effects of health insurance status on in-hospital mortality. Multicollinearity was determined by using variance inflation factors. The statistical significance of the association between health insurance status and in-hospital mortality was assessed via Wald χ^2 test. The area under the receiver operating characteristic curve (AUC) was used to assess statistical model discrimination. Hosmer–Lemeshow test was conducted to evaluate the statistical significance of differences in the calibration of each model among deciles of the observed and predicted risks.

In view of the problems of overdispersion in the model and the clustered effect of patients within the same hospital, we constructed the multilevel mixed-effect negative binomial regression mode to estimate the effects of health insurance status on LOS.[31] The results from this model are in the form of log ratios between the variable and the reference group, which is known as the incidence rate ratio (IRR).

Categorical variables are presented as percentages and continuous variables as means ± standard deviation. The odds ratios (OR) with a 95% confidence interval (CI) and IRRs with a 95% CI are reported as the results of logistic regression models and negative binomial regression models, respectively. *P* values are two tailed. $P < 0.05$ was considered statistically significant. All analyses were performed in R software version 3.2.2 and Stata version 14.0 (Stata Crop, College Station, TX).

RESULTS

Patient and hospital characteristics

We identified 22392 patients for AMI, 8056 patients for HF, and 17161 patients for pneumonia in this study. The frequencies of patient and hospital characteristics stratified on the basis of health insurance status are listed in Table 1. Patients with UEBMI (39%) and NCMS (43%) represented the largest health insurance group for AMI, HF (UEBMI: 40%, NCMS: 42%), and pneumonia (UEBMI: 50%, NCMS: 32%). Male was the most common characteristic in all of the health insurance groups. Under each condition, the patients in the NCMS group were younger and more likely to be admitted under emergent conditions when they had AMI (34%) and HF (21%)

than the patients in the UEBMI group (*P*<0.001). For patients with AMI, 50% of them were admitted through outpatient medical services, and 48% were through emergency medical services. Meanwhile, this pattern of hospitalization was similar in HF (77% and 21%, respectively) and pneumonia (69% and 22%, respectively). Under each condition, the Charlson comorbidity index of the patients with NCMS was lower than that of the UEBMI patients (*P*<0.001). A majority of the patients in the Self-payment group also received health care in hospitals with high beds, and a large proportion of patients sought health care in hospitals located in the middle area of Shanxi.

Table 1. Patient and hospital characteristics, according to medical condition and condition-specific health insurance status.

Variable	Acute Myocardial Infarction						Heart Failure						Pneumonia					
	All patients	Insurance Status					All patients	Insurance Status					All patients	Insurance Status				
		UEBMI	URBMI	NCMS	Self-payment	*P*		UEBMI	URBMI	NCMS	Self-payment	*P*		UEBMI	URBMI	NCMS	Self-payment	*P*
Patient characteristics																		
No. of Patients(%)	22392(100.0)	8664(38.7)	1494(6.7)	9656(43.1)	2578(11.5)		8056(100.0)	3239(40.2)	721(9.0)	3395(42.1)	701(8.7)		17161(100.0)	8540(49.8)	1273(7.4)	5459(31.8)	1889(11.0)	
Age — year	61.3±12.6	63.0±12.8	63.7±13.3	59.6±11.8	60±13.2	<0.001	67.5±13.1	69.9±12.2	69.3±13.5	65.0±12.9	66.6±15.3	<0.001	64.3±16.7	66.8±15.5	65.1±19.2	61.0±16.1	62.0±19.4	<0.001
Female (%)	5614(25.1)	1439(16.6)	709(47.5)	2821(29.2)	645(25.0)	<0.001	3794(47.1)	1038(32.0)	514(71.3)	1888(55.6)	354(50.5)	<0.001	6811(39.7)	2648(31.0)	824(64.7)	2511(46.0)	828(43.8)	<0.001
Admission source(%)						<0.001						<0.001						<0.001
Outpatient medical services	11207(50.0)	4151(47.9)	655(43.8)	5123(53.1)	1278(49.6)		6221(77.2)	2507(77.4)	530(73.5)	2709(79.8)	475(67.8)		118318(68.9)	5854(68.5)	844(66.3)	3999(73.3)	1134(60.0)	
Emergency medical services	10664(47.6)	4277(49.4)	811(54.3)	4331(44.9)	1245(48.3)		1695(21.0)	659(20.3)	185(25.7)	635(18.7)	216(30.8)		3849(22.4)	1966(23.0)	338(26.6)	1050(19.2)	495(26.2)	
Referral	245(1.1)	84(1.0)	11(0.7)	123(1.3)	27(1.0)		15(0.2)	5(0.2)	1(0.1)	7(0.2)	2(0.3)		1119(6.5)	502(5.9)	72(5.7)	338(6.2)	207(11.0)	
Others	276(1.2)	152(1.8)	17(1.1)	79(0.8)	28(1.1)		125(1.6)	68(2.1)	5(0.7)	44(1.3)	8(1.1)		362(2.1)	218(2.6)	19(1.5)	72(1.3)	53(2.8)	
Admission condition(%)						<0.001						<0.001						<0.001
Regular	11337(50.6)	4279(49.4)	747(50.0)	4971(51.5)	1340(52)		6124(76.0)	2490(76.9)	549(76.1)	2556(75.3)	529(75.5)		13658(79.6)	6785(79.5)	1012(79.5)	4388(80.4)	1473(78.0)	
Emergency	6682(29.8)	2492(28.8)	421(28.2)	3266(33.8)	503(19.5)		1474(18.3)	538(16.6)	124(17.2)	702(20.7)	110(15.7)		2255(13.1)	1138(13.3)	166(13.0)	724(13.3)	227(12.0)	
Urgent	4373(19.5)	1893(21.8)	326(21.8)	1419(14.7)	735(28.5)		458(5.7)	211(6.5)	48(6.7)	137(4.0)	62(8.8)		1248(7.3)	617(7.2)	95(7.5)	347(6.4)	189(10.0)	
Charlson Comorbidity Index	3.9±1.9	4.2±1.9	4.4±2.0	3.7±1.7	3.6±1.9	<0.001	4.8±1.9	5.2±1.9	4.9±1.9	4.5±1.8	4.9±2.2	<0.001	3.9±2.2	4.2±2.2	4.0±2.3	3.5±2.1	3.7±2.5	<0.001
Hospital characteristics																		
Hospital beds	1145.4±363.8	1155.3±355.3	1087.5±332.8	1123.8±383.6	1226.4±315.3	<0.001	1032.8±325.4	1077.9±312.3	1019.3±310.9	969.4±332.1	1145.1±302.1	<0.001	1199.7±382.3	1227.6±368.4	1163.1±378.8	1129.7±413.6	1300.2±308.2	<0.001
Number of nurses per 100 beds	65.9±13.0	64.2±12.8	63.4±12.8	68.1±64.9	64.9±12.2	<0.001	35.1±15.0	36.2±14.8	37.1±14.9	33.9±15.4	33.4±12.7	<0.001	32.8±11.5	33.2±11.2	34.4±11.6	32.3±12.5	31.6±9.9	<0.001
Number of doctors per 100 beds	41.8±7.9	41.5±7.9	42.1±7.6	42.5±8.1	40.2±6.7	<0.001	36.8±9.0	37.2±8.6	37.4±10.1	36.5±9.1	36.1±8.6	<0.001	36.1±8.7	36.5±8.3	36.3±9.4	35.4±9.1	36.4±8.6	<0.001
Hospital volume (%)						<0.001						<0.001						<0.001
Below median	11823(52.8)	4956(57.2)	977(65.4)	4978(51.6)	912(35.4)		4054(50.3)	1755(54.2)	375(52.0)	1657(48.8)	267(38.1)		8466(49.3)	3560(41.7)	687(54.0)	3519(64.5)	700(37.1)	
Above median	10569(47.2)	3708(42.8)	517(34.6)	4678(48.4)	1666(64.6)		4002(49.7)	1484(45.8)	346(48.0)	1738(51.2)	434(61.9)		8695(50.7)	4980(58.3)	586(46.0)	1940(35.5)	1189(62.9)	
Hospital region (%)						<0.001						<0.001						<0.001
North	3770(16.8)	1533(17.7)	216(14.5)	1231(12.7)	790(30.6)		1768(22.0)	861(26.6)	133(18.4)	462(13.6)	312(44.5)		3084(18.0)	1530(17.9)	163(12.8)	716(13.1)	675(35.7)	
South	8839(39.5)	2645(30.5)	500(33.5)	4999(51.8)	695(27.0)		2774(34.4)	818(25.2)	221(30.7)	1577(46.5)	158(22.5)		4446(25.9)	1587(18.6)	323(25.4)	2177(39.9)	359(19.0)	
Middle	9783(43.7)	4486(51.8)	778(52.1)	3426(35.5)	1093(42.4)		3514(43.6)	1560(48.2)	367(50.9)	1356(39.9)	231(33.0)		9631(56.1)	5423(63.5)	787(61.8)	2566(47.0)	855(45.3)	

UEBMI, the urban employee-based basic medical insurance; URBMI, urban resident-based basic medical insurance scheme; NCMS, the rural new cooperative medical scheme.

Plus-minus values are means ± standard deviation. Percentages may not total 100 because of rounding.

Unadjusted outcomes

The unadjusted outcomes of the health insurance groups are presented in Table 2. The overall in-hospital mortality rates for AMI, HF, and pneumonia were 4.0%, 3.4%, and 7.7%, respectively. In-hospital mortality following pneumonia was highest for NCMS (11.1%) and URBMI (9.1%) patients. Under each condition, the NCMS patients incurred the highest unadjusted in-hospital mortality (4.7%, 4.4%, and 11.1% for AMI, HF, and pneumonia, respectively) among all health insurance groups (P<0.001), while UEBMI patients yielded the lowest unadjusted in-hospital mortality (3.1%, 2.4%, and 5.7% for AMI, HF, and pneumonia, respectively) (P<0.001).

The mean LOS for AMI, HF, and pneumonia were 11.7±6.6 days, 10.5±6.2 days, and 13.0±9.4 days, respectively. Under each condition, the patients in the UEBMI group conferred the longest unadjusted mean LOS (12.5±7.8 days, 11.6±6.3 days, and 13.9±9.9 days for AMI, HF, and pneumonia, respectively) among all the health insurance groups followed by URBMI group.

Table 2 Unadjusted outcomes for all patients with acute myocardial infarction, heart failure, and pneumonia by health insurance status.

Outcome	UEBMI	URBMI	NCMS	Self-payment	*P*
Acute Myocardial Infarction					
In-hospital mortality	3.1%	4.4%	4.7%	4.2%	<0.001
Length of stay (days)	12.5±7.8	12.1±6.1	11.2±5.6	10.6±6.0	<0.001
Heart Failure					
In-hospital mortality	2.4%	2.8%	4.4%	3.9%	<0.001
Length of stay (days)	11.6±6.3	10.3±5.5	9.6±6.1	10.0±6.3	<0.001
Pneumonia					
In-hospital mortality	5.7%	9.1%	11.1%	5.7%	<0.001
Length of stay (days)	13.9±9.9	13.1±9.5	11.9±8.0	11.9±10.5	<0.001

UEBMI, the urban employee-based basic medical insurance; URBMI, urban resident-based basic medical insurance scheme; NCMS, the rural new cooperative medical scheme.

Adjusted outcomes for the effect of health insurance status

Table 3 shows the results of multilevel multivariable analyses of the relationship between health insurance status and in-hospital mortality and LOS after patient- and hospital-level covariates were controlled.

Table 3 Adjusted outcomes for the effect of health insurance status among patients with acute myocardial infraction, heart failure, and pneumonia.

Outcome	UEBMI	URBMI	NCMS	Self-payment	AUC
Acute Myocardial Infarction					
In-hospital mortality	1.0	1.22 (0.91-1.63)	1.39 (1.17-1.66)***	1.69 (1.31-2.20)***	0.80
Length of stay(days)	1.0	0.96 (0.93-0.98)***	0.90 (0.89-0.92)***	0.85 (0.83-0.87)***	-
Heart Failure					
In-hospital mortality	1.0	1.31 (0.76-2.27)	1.93 (1.37-2.74)***	1.38 (0.84-2.27)	0.82
Length of stay(days)	1.0	0.90 (0.87-0.94)***	0.85 (0.82-0.87)***	0.87 (0.84-0.91)***	-
Pneumonia					
In-hospital mortality	1.0	1.64 (1.29-2.10)***	1.97 (1.69-2.30)***	1.48 (1.17-1.87)***	0.83
Length of stay(days)	1.0	0.95 (0.92-0.99)***	0.87 (0.85-0.89)***	0.88 (0.85-0.90)***	-

UEBMI, the urban employee-based basic medical insurance; URBMI, urban resident-based basic medical insurance scheme; NCMS, the rural new cooperative medical scheme; AUC, area under receiver operator curve.

*P<0.1, ** P<0.05, *** P<0.01. In-hospital mortality reported as adjusted odds ratio (95% confidence interval). Length of stay reported as incidence rate ratio (95% confidence interval). Reference group: UEBMI. Outcomes adjusted for patient age, gender, health insurance status, admission source, admission condition, Charlson comorbidity index, hospital volume, number of hospital beds (per increases 100 beds), number of nurses per 100 beds, number of doctors per 100 beds, and hospital geographic region.

Compared with the UEBMI patients, adjusted in-hospital mortality among AMI patients was significantly higher for NCMS (adjusted odds ratio (OR) 1.39, 95% CI=1.17-1.66) and Self-payment (OR=1.69, 95% CI= 1.31-2.20), and among HF patients was significantly higher for NCMS (OR=1.93, 95% CI=1.37-2.74), and among pneumonia patients was significantly higher for URBMI (OR=1.64, 95% CI= 1.29-2.10), NCMS (OR=1.97, 95% CI= 1.69-2.30) and Self-payment (OR=1.48, 95% CI= 1.17-1.87). In additional, the results of multilevel mixed-effect negative binomial regression models similarly demonstrated that the LOS of URBMI, NCMS, and

Self-payment groups under each condition was significantly shorter than that of the UEBMI group (P<0.001). For example, after the patient and hospital characteristics were adjusted in the cases of AMI, our model suggested that the patients in NCMS stayed approximately 90% of the time in the hospital compared with the patients in UEBMI.

DISCUSSION

This study sought practical evidence to determine whether there are insurance-related differences in health outcomes by using administrative data from 31 tertiary hospitals in Shanxi, China, focusing on AMI, HF, and pneumonia. It was found that health insurance status is associated with in-hospital mortality and LOS, even after controlling for patient- and hospital-level covariates. Our results suggested that patients with NCMS have significantly higher risk-adjusted in-hospital morality and shorter LOS in all 3 conditions than patients with UEBMI, although the association between insurance status and in-hospital mortality and LOS varied by diseases in this study.

The impact of health insurance status on health outcomes in China is a recent focus of research. Our results of patients with AMI are consistent with the findings of Liu *et al.*[11] Furthermore, our study expanded upon the limited literature on insurance-related disparities in China in several aspects. First, a broad population comprising patients with AMI, HF, and pneumonia was included in our study and thus helped us examine the effects of health insurance status on health outcomes under diverse medical conditions within a large population. Second, the hospital data we used in this work were within 2014–2015, which could reflect the situation several years later since China launched its new health care reform in 2009. Third, given the cluster effects, we applied the multilevel mixed-effect logistic regression model and the multilevel mixed-effect negative binomial regression model to quantify the effects of health insurance status on in-hospital mortality and LOS, respectively. Thus, these models could provide a more exact estimation than conventional logistic regression and linear regression model.

In view of the disparities across health insurance groups, a key question emerges: why are there disparities in health outcomes across health insurance groups, especially between NCMS and UEBMI?

One possible explanation is the wide gap in financial protections. The financial protection of UEBMI is higher than that of NCMS because of greater financing capacity.[1, 32, 33] UEBMI has higher financial protection than NCMS, which may encourage people with UEBMI to consume more health care resource, such as having more hospitalization and longer LOS. An investigation conducted in Zhejiang and Gansu reported that people with UEBMI and URBMI were more likely to seek for both inpatient and outpatient care than those with NCMS and with no insurance.[34] In a study conducted by Ma in 2010,[35] medical insurance predicted the LOS of cerebral infarction, and patients in the medical insurance with higher financial supports might be prone to prolong LOS although more treatments were not required. Apart from the financial support from insurance fund, the personal financial situation also matters.

The attendants who are eligible for UEBMI usually have stable job as well as high income level,[9] and their payment capacity to high-priced treatments or medications that may improve their health outcomes is stronger than NCMS participants. Furthermore, from the perspective of health providers, they may be vigilant regarding new and expensive treatment forms and even provide different treatments for patients with the same condition but with different insurance status.[36] Patients with higher levels of payments may be given higher priority to receive health care services.[37]

Another possible explanation is the wide gap in benefit coverage across insurance schemes. As reported by the World Health Organization, the SHI schemes in China varies largely in the following dimensions: breath (percentage of population covered), depth (percentage of health costs covered), and scope (type of health services covered).[38] NCMS covered more population than the UEBMI, but it was inferior in terms of depth and scope, and NCMS participants possess lower reimbursement level and smaller service coverage.[39-41] In 2011, the reimbursement rate of inpatient care for NCMS was 44%, while it was 68% for UEBMI participants.[3] In addition, UEBMI patients have more comprehensive services coverage than NCMS patients, with the expenses of some medical service items reimbursed to patients with UEBMI rather than patients with NCMS. The lower reimbursement level and more limited services coverage mean higher out-of-pocket expenses to patients with NCMS, and may influence their choice of treatments and time to surgery, eventually resulting in the significant differences of health outcomes. For instance, dual anti-platelet therapy (DAPT) is an essential therapy for patients who received reperfusion therapy, while it means heavy economic burden to some NCMS patients because of the high cost and low reimbursement percentage of this therapy.[11] Therefore, the DAPT adherence was lower in the NCMS group than that in other health insurance groups, which finally lead to higher in-hospital mortality. Additionally, NCMS patients tend to take medical cost as priority when they decide whether receive treatment or not, which may cause treatment delay and eventually affect the prognosis of patients.[11] Other possible explanations, such as the experience of physicians, differences in procedures, education level, and lifestyle, accounting for the differences in health insurance status have been suggested by relevant studies,[42-44] but empirical evidence in China remains insufficient.

Since the SHI schemes was criticized for its fragmentation, calls for the consolidation of SHI schemes toward an equitable and efficient system have increased in recent years,[45-47] but the progress of the consolidation is slow. Several provinces or municipalities have piloted the consolidation of these schemes and some evidence showed that the consolidation contributed to the equitable access to health care and efficiency of the system.[45] In early 2016, the State Council of People's Republic of China promulgated a guideline on the integration of the URBMI and the NCMS, aiming to create a unified basic health insurance system. The URBMI and NCMS would be unified in six areas: insurance coverage, insurance finance, payment standard, medicine and medical service item catalog, management of the qualified insurance institutions, and insurance accounting.[48] This policy guideline has promoted the consolidation of SHI schemes in China, which provides an alternative way to narrow the gaps between different insurance programs and improve health equity. However, the consolidation may take a long process considering the lack of specific matching plans or policies, difficulty in merging administrative institutions and staff, unifying funding level and benefit packages, reforming payment systems, and strengthening information systems.[36, 45]

Policy implications

The universal health insurance coverage in China has improved the accessibility to health care services, but the government has paid little attention to the disparities of health outcomes among health insurances. This study reveals the disparities of in-hospital mortality and LOS across different insurance schemes. We suggest that policies be made to narrow the gaps of insurance benefits for patients with AMI, HF, or pneumonia, such as increasing reimbursement rate for NCMS and URBMI, expanding the service coverage for NCMS and URBMI, and consolidating SHI schemes. On the other hand, policy makers should adjust the reimbursement policies of some expensive treatments according to the results of clinical practice and economic assessment, such as increasing the reimbursement rate of DAPT for AMI patients with NCMS.

Limitations

This study has several limitations. First, although our study suggested the association between health insurance status and health outcomes, we are unable to identify a causal relation because of the cross-sectional research design. Second, although three common conditions we analyzed represent a large proportion of hospitalizations in

Shanxi, the results of these data were difficult to generalize into the full spectrum of hospitalizations or patients in other levels of hospitals in China. Finally, although we anticipated many challenges in data collection, it is difficult to capture all potential confounders in our study. Some details on treatment information and individual socioeconomic status that might be related to health outcomes, such as medications, employment, income and education, were not available to this study. Therefore, these data were not included in our analysis despite such information being an important indicator of health care quality. However, to reduce potential bias from the unmeasured confounders, we collected the patient and hospital characteristics adopted by previous studies in our database as much as possible and used standard and well-accepted risk-adjustment techniques.

Further research

The observed disparities in our study reveal the potential influence of insurance status on health outcomes in inpatient service practices in Shanxi, China. However, the underlying mechanisms of the association between insurance status and health outcomes are complicated. Further research is necessary to explore the underlying mechanisms of this relationship and validate this relationship under other diagnoses, such as cardiovascular surgery, orthopedic surgery, and tumor therapy. Also, future studies focusing on various dimensions of quality, including process of care and the experience of patients, are warranted.

CONCLUSIONS

Health insurance status is associated with the health outcomes of patients who were hospitalized for AMI, HF, and pneumonia in Shanxi, China. In particular, the adjusted in-hospital mortality rate of NCMS patients was significantly higher and their LOS was shorter than those of UEBMI patients. Further research should be conducted to understand the mechanisms of the effects of health insurance status on health outcomes to support policy formulation and implementation. Policies also should be considered and formulated by the government to minimize the gaps across different insurance schemes and further improve the equity of health care delivery in China.

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REFERENCES

1. Yip WC, Hsiao WC, Chen W, *et al*. Early appraisal of China's huge and complex health-care reforms. *Lancet* 2012;379:833-42.

2. Tang S, Brixi H, Bekedam H. Advancing universal coverage of healthcare in China: translating political will into policy and practice. *Int J Health Plann Manage* 2014;29:160-74.

3. Meng Q, Xu L, Zhang Y. Trends in access to health services and financial protection in China between 2003 and 2011: a cross-sectional study. *Lancet* 2012;379:805-14.

4. Liang L, Langenbrunner J. *The long march to universal coverage: lessons from China*. Washington, DC: World Bank 2013:5.

5. Dong K. Medical insurance system evolution in China. *China Econ Rev* 2009;20:591-7.

6. National Health and Family Planning Commission of the People's Republic of China. *2016 China statistical yearbook of health and family planning*. Beijing: Peking Union Medical College Press, 2016.

7. Department of Population and Employment Statistics of National Bureau of Statistics, Department of Planning and Finance of Ministry of Human Resource and Social Security. *China Labour Statistical Yearbook 2015*. Beijing: China Statistics Press, 2015.

8. Sun Y, Gregersen H, Yuan W. Chinese health care system and clinical epidemiology. *Clinical Epidemiology* 2017;9:167–78.

9. Liu X, Wong H, Liu K. Outcome-based health equity across different social health insurance schemes for the elderly in China. *BMC Health Serv Res* 2015;16:1-12.

10. Yu B. Influences of health insurance status on clinical treatments and outcomes for 4,714 patients after acute myocardial infarction in 14 Chinese general hospitals. *J Med Dent Sci* 2005;52:143-51.

11. Liu B, Yan H, Guo R, *et al*. The basic social medical insurance is associated with clinical outcomes in the patients with st-elevation myocardial infarction: a retrospective study from Shanghai, China. *Int J Med Sci* 2014;11:905-17.

12. Wang Z, Zhang Y, Xiong F, *et al*. Association between medical insurance type and survival in patients undergoing peritoneal dialysis. *BMC Nephrol* 2015;16:33.

13. Kong Y, Wang Y, Zhang JH, *et al*. Disparities in medical expenditure and outcomes among patients with intracranial hemorrhage associated with different insurance statuses in southwestern China. *Acta Neurochir Suppl* 2011;111:337-41.

14. Feng Y, Xiong X, Xue Q, *et al*. The impact of medical insurance policies on the hospitalization services utilization of people with schizophrenia: A case study in Changsha, China. *Pak J Med Sci* 2013;29:793-8.

15. Fang H, Meng Q, Rizzo JA. Do different health insurance plans in China create disparities in health care utilization and expenditures? *International Journal of Applied Economics*. 2014;11:1-18.

16. The Bureau of Statistics in Shanxi, China. *Shanxi Statistical Yearbook*. Beijing:

China Statistics Press, 2015.

17. National Center for Cardiovascular Disease, China. *Report on cardiovascular disease in China 2015*. Beijing: Encyclopedia of China Publishing House, 2016.
18. Jiang H, Ge J. Epidemiology and clinical management of cardiomyopathies and heart failure in China. *Heart* 2009;95:1727-31.
19. Xu H, Li W, Yang J, *et al*. The China Acute Myocardial Infarction (CAMI) Registry: A national long-term registry-research-education integrated platform for exploring acute myocardial infarction in China. *Am Heart J*. 2016;175:193-222.
20. National Center for Cardiovascular Disease, China. *Report on cardiovascular disease in China 2014.* Beijing: Encyclopedia of China Publishing House, 2015.
21. He J, Gu DF, Wu XG, *et al*. Major causes of death among men and women in China. *New Engl J Med*. 2005;353:1124-34.
22. He L, Chen X. Contentions on the pathogenic spectrum of community-acquired pneumonia and the first experimental application of antibiotic agents. *Chinese Journal of Practical Internal Medicine*. 2007;27:110-3.
23. Hasan O, Orav EJ, Hicks LS. Insurance status and hospital care for myocardial infarction, stroke, and pneumonia. *J Hosp Med* 2010;5:452-9.
24. Kim J, Lee SG, Lee K, *et al*. Impact of health insurance status changes on healthcare utilisation patterns: a longitudinal cohort study in South Korea. *BMJ Open* 2016;6:e9538.
25. LaPar DJ, Bhamidipati CM, Mery CM, *et al*. Primary payer status affects mortality for major surgical operations. *Ann Surg* 2010;252:544-51.

26. Spencer CS, Gaskin DJ, Roberts ET. The quality of care delivered to patients within the same hospital varies by insurance type. *Health Affair* 2013;32:1731-9.

27. Xu Y, Liu Y, Shu T, *et al*. Variations in the quality of care at large public hospitals in Beijing, China: a condition-based outcome approach. *PLoS One* 2015;10:e138948.

28. Quan HD, Sundararajan V, Halfon P, *et al*. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care* 2005;43:1130-9.

29. Charlson ME, Pompei P, Ales KL, *et al*. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 1987;40:373-83.

30. Rice N, Leyland A. Multilevel models: applications to health data. *J Health Serv Res Policy* 1996;1:154-64.

31. Carter EM, Potts HW. Predicting length of stay from an electronic patient record system: a primary total knee replacement example. *BMC Med Inform Decis Mak* 2014;14:26.

32. Liu K, Wu QB, Liu JQ. Examining the association between social health insurance participation and patients' out-of-pocket payments in China: The role of institutional arrangement. *Soc Sci Med* 2014;113:95-103.

33. Yu H. Universal health insurance coverage for 1.3 billion people: What accounts for China's success? *Health Policy*. 2015;119:1145-52.

34. Li X, Zhang W. The impacts of health insurance on health care utilization among

the older people in China. *Soc Sci Med* 2013;85:59-65.

35. Ma Y, Liu Y, Fu HM, *et al*. Evaluation of admission characteristics, hospital length of stay and costs for cerebral infarction in a medium-sized city in China. *Eur J Neurol* 2010;17:1270-6.

36. He AJ, Wu S. Towards universal health coverage via social health insurance in China: Systemic fragmentation, reform imperatives, and policy alternatives. *Appl Health Econ Health Policy* 2016:1-10.

37. Zhong H. Effect of patient reimbursement method on health-care utilization: evidence from China. *Health Econ* 2011;20:1312-29.

38. World Health Organization. Sustainable health financing, universal coverage and social health insurance. World Health Assembly Resolution, 2005, 58.

39. Fu R, Wang Y, Bao H, *et al*. Trend of urban-rural disparities in hospital admissions and medical expenditure in China from 2003 to 2011. *PLoS One* 2014;9:e1085719.

40. Wagstaff A, Lindelow M, Jun G, *et al*. Extending health insurance to the rural population: an impact evaluation of China's new cooperative medical scheme. *J Health Econ* 2009;28:1-19.

41. Barber SL, Yao L. Development and status of health insurance systems in China. *The Int J Health Plann Manage* 2011;26:339-56.

42. Canto JG, Rogers WJ, French WJ, *et al*. Payer status and the utilization of hospital resources in acute myocardial infarction: a report from the National Registry of Myocardial Infarction 2. *Arch Intern Med* 2000;160:817-23.

43. Mainous AGI, Diaz VA, Everett CJ, *et al*. Impact of insurance and hospital ownership on hospital length of stay among patients with ambulatory care–sensitive conditions. *Ann Fam Med* 2011;9:489-95.

44. Lantz PM, House JS, Lepkowski JM, *et al*. Socioeconomic factors, health behaviors, and mortality: results from a nationally representative prospective study of US adults. *JAMA* 1998;279:1703-8.

45. Meng Q, Fang H, Liu X, *et al*. Consolidating the social health insurance schemes in China: towards an equitable and efficient health system. *Lancet* 2015;386:1484-92.

46. Wang H, Liu Z, Zhang Y, *et al*. Integration of current identity-based district-varied health insurance schemes in China: implications and challenges. *Front Med* 2012;6:79-84.

47. Wang X, Zheng A, He X, *et al*. Integration of rural and urban healthcare insurance schemes in China: an empirical research. *BMC Health Serv Res* 2014;14:142.

48. State Council of People's Republic of China. Guideline for integration of basic medical insurance for urban employees and the new rural cooperative medical scheme. 2016. http://www.gov.cn/zhengce/content/2016-01/12/content_10582.htm. (accessed 22 Sep 2016).

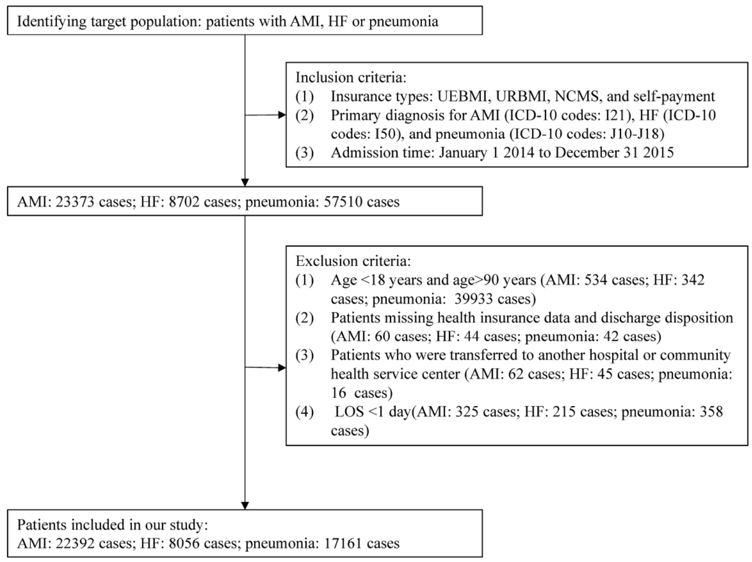

Figure 1 Flowchart of the sampling process. AMI, acute myocardial infarction; HF, heart failure; ICD-10, the international classification of diseases, tenth revision; NCMS, the new cooperative medical scheme; UEBMI, the urban employee-based basic medical insurance; URBMI, the urban resident-based basic medical insurance.

209x148mm (300 x 300 DPI)

Supplemental table 1 ICD-10 codes identifying index admissions with acute myocardial infarction, heart failure, and pneumonia

Diseases	ICD-10 codes
Acute Myocardial Infarction	I21.000, I21.001, I21.002, I21.003, I21.004, I21.005, I21.006, I21.007, I21.100, I21.101, I21.102, I21.103, I21.104, I21.105, I21.200, I21.201, I21.202, I21.203, I21.204, I21.205, I21.206, I21.300, I21.301, I21.302, I21.303, I21.400, I21.401, I21.402, I21.900
Heart Failure	I50.000, I50.001, I50.100, I50.900, I50.901, I50.902, I50.903, I50.904, I50.905, I50.906
Pneumonia	J10.000, J10.001, J10.100, J10.101, J10.800, J10.801, J10.802, J11.000, J11.100, J11.101, J11.102, J11.800, J12.000, J12.100, J12.200, J12.800, J12.900, J13.x00, J14.x00, J15.000, J15.001, J15.100, J15.101, J15.102, J15.200, J15.300, J15.400, J15.401, J15.402, J15.500, J15.600, J15.601, J15.602, J15.700, J15.800, J15.900, J15.901, J15.902, J15.903, J16.000, J16.800, J18.000, J18.001, J18.100, J18.200, J18.800, J18.801, J18.900, J18.901, J18.902

ICD-10, the International Classification of Diseases, 10th Revision

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	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	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-8
Objectives	3	State specific objectives, including any prespecified hypotheses	8
Methods			
Study design	4	Present key elements of study design early in the paper	9
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	9
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	10
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	11-12
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	*11-12*
Bias	9	Describe any efforts to address potential sources of bias	12
Study size	10	Explain how the study size was arrived at	11
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	12
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	12-13
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	10-11
		(*e*) Describe any sensitivity analyses	

Continued on next page

Results			**Page**
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	13-14
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	15
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	*16*
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	16-18
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	18
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	22-23
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	19-21
Generalisability	21	Discuss the generalisability (external validity) of the study results	22-23
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	25

*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.

BMJ Open

Insurance status, in-hospital mortality and length of stay in hospitalized patients in Shanxi, China: a cross-sectional study

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Insurance status, in-hospital mortality and length of stay in hospitalized patients in Shanxi, China: a cross-sectional study

Xiaojun Lin[1], Miao Cai[1,2], Hongbing Tao[1], Echu Liu[2], Zhaohui Cheng[1], Chang Xu[1], Manli Wang[1], Shuxu Xia[1], Tianyu Jiang[1]

Authors' affiliations:

[1] Department of Health Administration, School of Medicine and Health Management, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China

[2] Department of Health Management and Policy, College for Public Health and Social Justice, Saint Louis University, Saint Louis, MO, USA

Corresponding author: Hongbing Tao, School of Medicine and Health Management, Tongji Medical College, Huazhong University of Science and Technology. No. 13 Hangkong Rd., 430030, Wuhan, P.R. China

Tel: 0086-27-83692531, Fax: 0086 -27-83692727, E-mail: hhbtao@hust.edu.cn

Keywords: insurance status, mortality, length of stay, acute myocardial infarction, heart failure, pneumonia, cross-sectional

Word count: 4142

ABSTRACT

Objectives: To determine insurance-related disparities in hospital care for patients with acute myocardial infarction (AMI), heart failure (HF), and pneumonia.

Setting and participants: A total of 22,392 patients with AMI, 8,056 patients with HF, and 17,161 patients with pneumonia were selected from 31 tertiary hospitals in Shanxi, China, from 2014 to 2015 using International Classification of Diseases, Tenth Revision codes. Patients were stratified by health insurance status, namely, urban employee-based basic medical insurance (UEBMI), urban resident-based basic medical insurance (URBMI), new cooperative medical scheme (NCMS), and self-payment.

Outcome measures: In-hospital mortality and length of stay (LOS).

Results: The highest unadjusted in-hospital mortality rate was detected in NCMS patients independent of medical conditions (4.7%, 4.4%, and 11.1% for AMI, HF, and pneumonia, respectively). The lowest unadjusted in-hospital mortality rate and the longest LOS were observed in UEBMI patients. After controlling patient- and hospital-level covariates, the adjusted in-hospital mortality was significantly higher for NCMS and self-payment among AMI patients, for NCMS among HF patients, and for URBMI, NCMS, and self-payment among pneumonia patients compared with UEBMI. The LOS of the URBMI, NCMS, and self-payment groups was significantly shorter than that of the UEBMI group.

Conclusions: Insurance-related disparities in hospital care for patients with three common medical conditions were observed in this study. NCMS patients had

significantly higher adjusted in-hospital mortality and shorter LOS compared with UEBMI patients. Policies on minimizing the disparities among different insurance schemes should be established by the government.

Strengths and limitations of this study

- This comprehensive study explores the association between health insurance status and health outcome in Shanxi province in China, revealing the disparities among four insurance groups regarding adjusted in-hospital mortality and LOS for consideration for policymakers.
- This study is based on a broad population comprising patients with AMI, HF, and pneumonia.
- We are unable to capture all potential confounders in our study, especially the socioeconomic information of patients, because of the limited use of an administrative database.
- Patients in other levels of hospitals in Shanxi Province, China, were not included in this study.

INTRODUCTION

The Chinese government launched its new nationwide health-care reform in 2009 to provide affordable and equitable access to health care.[1] With advancements in this reform, the Chinese government has shown remarkable political will and commitment to universal health coverage.[2] The current Chinese social health insurance (SHI) system consists of the urban employee-based basic medical insurance (UEBMI), urban resident-based basic medical insurance (URBMI), and the new cooperative medical scheme (NCMS). The coverage of SHI rose from 29.7% in 2003 to more than 95% of the Chinese population in 2011,[3] and this advancement was lauded as an "unparalleled" achievement.[4]

However, these three insurance schemes differ substantially in target population, administration, source of funding, funding level, and benefit packages.[1,5] Specifically, the UEBMI (initiated in 1994 and launched in 1998) is a mandatory program targeting at urban employees and retired employees.[4] In 2014, 283 million urban employees were rolled in the UEBMI.[6] The annual premium of the UEBMI (8% of the payroll) is shared between employers and employees, wherein employers pay 6% as tax and employees pay 2%. The per-capita fund of UEBMI is approximately six and seven times higher than other two insurance programs, reaching around 2,840.6 yuan in 2014.[6] The UEBMI provides the most comprehensive coverage, including both inpatient and outpatient care services, with the inpatient reimbursement rate of approximately 80% in 2014. Unlike the UEBMI, URBMI (initiated in 2007 and formally launched in 2009) is a voluntary program aiming at covering urban residents who were not covered by the UEBMI. By the end of 2014, 314.5 million urban residents have participated in the URBMI.[6] Its premium was highly subsidized by the government, while individuals contribute a small proportion. The per-capita fund of URBMI was 524.4 yuan in 2014.[7] The reimbursement rate for inpatient and outpatient care increased with time and reached 70% and 50% in 2014, respectively.[8] Both UEBMI and URBMI funds were pooled at prefecture/municipality level and administrated by the Ministry of Human Resource and Social Security. The NCMS was initiated in 2003 and formally launched in 2006. It is also a voluntary program aiming to cover rural residents. By 2014, the NCMS has covered 736 million rural residents, accounting for 98.9% of the rural population.[8] Similar to URBMI, the government subsidies are the major funding sources of NCMS, while the participants pay for a small proportion. The NCMS covered primarily inpatient care and some outpatient services for selected chronic conditions, and its reimbursement rate for inpatient and outpatient care reached 75% and 50% in 2014, respectively. NCMS was pooled at county level and managed by the Chinese National Health and Family Planning Commission. In China, type of registration (rural or urban) and employment status, rather than self-selection, are major determinants of insurance scheme enrollment.[9]

In China's recent health-care reform, universal health coverage has improved the accessibility to health-care services, but this phenomenon does not guarantee equality in health outcome and health-care utilization of individuals enrolled in different insurance schemes. Recently, a few studies in China have explored the disparities in health outcome and health-care utilization across different health insurance groups, specifically among patients with acute myocardial infarction (AMI),[10,11] peritoneal dialysis,[12] intracranial hemorrhage,[13] and schizophrenia.[14] In 2005, Yu[10] analyzed the medical records of 4,714 patients with AMI and found that insurance status was not associated with in-hospital mortality significantly, whereas uninsured AMI patients were less likely to receive interventions and medications and had a shorter length of stay (LOS). However, in a study exploring the association between medical insurances and clinical outcomes for patients with ST elevation myocardial infarction in Shanghai, Liu et al.[11] found that the incidence of major adverse events and cardiac mortality of patients with NCMS was higher than those of patients with other insurance types. Wang et al.[12] performed a single-center study and demonstrated that the survival rate of NCMS patients in 5 years is lower than that of UEBMI patients with peritoneal dialysis. Kong et al.[13] compared the differences of in-hospital mortality and LOS by insurance types, and they found that patients locally insured had higher death rate and longer LOS than both nonlocally insured and uninsured patients, but risk adjustment was not conducted in their study. Feng et al.[14] explored the impact of medical insurance policies on the hospitalization service utilization of patients with schizophrenia and revealed that patients with UEBMI were admitted in high-level medical institutions and received costly medications. Fang et al.[15] indicated that UEBMI respondents were more likely to receive preventive health-care services than NCMS respondents. Liu et al.[9] found that UEBMI participants achieved better self-reported health status, physical functions, and psychological well-being than

URBMI, NCMS, and uninsured participants did using the data of the National Survey of the Aged Population in Urban/Rural China in 2006 and 2010.

Previous studies have indicated that there are insurance-related disparities in health outcomes and health-care utilization in several diseases or specific populations, but whether this relationship persists in a wider population or other diseases remains unknown. Moreover, the risk adjustment and the nest or cluster effects (i.e., patients treated at the same hospital experience similar outcomes) were ignored in previous studies in China, which may result in biased estimations and provide wrong evidence in the policy formulation process.

This study proposes to explore the disparities among three SHI groups and self-payment group (i.e., patients who pay the cost of care without reimbursement) regarding adjusted in-hospital mortality and LOS to fill in the gap in the literature. The primary reason why we choose AMI, heart failure (HF), and pneumonia is that they are common conditions in China. Further, we can compare our results with previous studies that analyzed patients with AMI. We used a large administrative database in Shanxi to examine this important question. Previous studies suggest that both NCMS and URBMI have lower funding level and more limited benefit packages than UEBMI and that NCMS participants have worse outcomes and utilize less health-care services;[9,11,12] hence, we hypothesized that NCMS and URBMI patients hospitalized with AMI, HF, and pneumonia have higher adjusted in-hospital mortality and shorter LOS than that of UEBMI patients.

METHODS

Data source

Shanxi Province is located in Northern China. It has 36.5 million residents, with 53.79% living in urban areas in 2014.[16] According to the statistics of the National Health and Family Planning Commission, Shanxi had 37 tertiary hospitals in 2014 and 2015, but the data in six tertiary hospitals were unavailable for the study team. Therefore, we only included 31 tertiary hospitals in Shanxi.

We conducted a retrospective study of patients hospitalized between January 1, 2014, and December 31, 2015, using administrative data from hospital electronic health records (EHRs). The data contain over 200 variables, including patients' sociodemographic characteristics (e.g., age, gender, race/ethnicity, occupation, and insurance status), diagnosis codes (i.e., principal diagnosis code, up to 10 secondary diagnosis codes), up to seven procedure codes, total costs, service charges in sub-categories, LOS, and outcomes (such as discharge status and medical adverse events during the hospitalization). The EHRs in those hospitals follow a national template and have adopted standardized disease coding in International Classification of Diseases, Tenth Revision (ICD-10). The EHRs from various hospitals in Shanxi were entered by qualified coders who have received professional coding training and were certified by the Medical Record Management Association of the Chinese Hospital Association. In addition, the study team randomly sampled 10% of the EHRs to validate the accuracy of variables, such as patients' demographic characteristics, insurance type, principal and secondary diagnosis codes, and LOS. The overall variable accuracy reached approximately 97%. All patient, medical staff, and hospital identifiers, such as name, ID card number, address, postcode, and insurance number, were excluded before the data were provided to the study team.

Patients

We used ICD-10 codes with variations in the three digits after the decimal point. Then, we identified all patients with the principal diagnosis of AMI (ICD-10 codes: I21.x), HF (ICD-10 codes: I50.x), and pneumonia (ICD-10 codes: J10.x-J18.x) between January 1, 2014, and December 31, 2015 (see supplemental Table 1). We chose the three diseases as the subject of this study for the following reasons. Cardiovascular disease (CVD) remains the leading cause of death in China, with mortality rates of 42.5% in urban areas and 44.6% in rural areas attributed to CVD.[17] AMI and HF have been two common causes of hospitalization in China.[18,19] In 2014, 290 million patients were estimated with CVD, and one in five Chinese adults suffered from CVD. Among individuals with CVD, 2.5 million had a myocardial infarction and 4.5 million had a heart failure.[20] Similarly, pneumonia is one of the leading causes of death in adults and children in China,[21] and 2.5 million people were estimated to suffer from pneumonia annually and that 5% of them die of pneumonia-related diseases.[22]

Patients in the UEBMI, URBMI, NCMS, and self-payment groups were selected for further analyses. As shown in Figure 1, we excluded patients under 18 years and over 90 years and patients with missing health insurance data and discharge disposition. In addition, we excluded patients who were transferred to another hospital or community health service centers because their admissions were truncated and subsequent treatment information in other facilities was unavailable for our study. Furthermore, we excluded patients who were discharged alive within one day after admission because they were likely to leave against medical advice and the treatment time was very limited.

Study variables

In-hospital mortality and LOS were selected as the measures of health outcomes during hospitalization. In-hospital mortality was defined as all deaths that occurred during hospital stay, and LOS was defined as the period from the day of admission to the day of hospital discharge.

The core independent variable was health insurance status, including UEBMI, URBMI, and NCMS, as well as self-payment. Previous studies suggested that patients with UEBMI have better outcomes and utilize more health-care resource than other insurance types;[9,11,12] hence, UEBMI was selected as the reference group in this study. We selected patient- and hospital-level covariates based on previous studies to assess the association of health insurance status and health outcomes (adjusted in-hospital mortality and LOS)[.23-26] Patient-level covariates included age, gender, admission source, admission condition, and comorbid disease. The four categories for admission source were as follows: outpatient medical services, emergency medical services, referral, and other sources. The conditions for admission, which is set as a proxy of disease severity,[27] were classified into three groups, namely, emergency, urgent, and regular conditions. Comorbidities were identified from secondary diagnosis, and Charlson comorbidity index was considered to assess the effect of comorbid diseases or disorders.[28,29] In this study, the 31 selected tertiary hospitals were teaching hospitals owned by the government. Therefore, we included the following hospital-level covariates: hospital volume, number of hospital beds, number of nurses per 100 beds, number of doctors per 100 beds, and hospital region. Hospital volume was defined as the total inpatients who were treated at hospitals using annual condition-specific volume averaged over the 2-year period. For the purposes of characterizing the sample, hospitals were categorized into two groups according to the median of hospital volume. The hospital region was classified into three groups, namely, south, north, and middle areas.

Statistical analysis

Patient- and hospital-level covariates and unadjusted outcomes were compared through ANOVA or Kruskal-Wallis test for continuous variables and either Pearson χ^2 analysis or Fisher exact test for categorical variables as appropriate.

We used multilevel mixed-effects logistic regression models to estimate the adjusted effects of health insurance status on in-hospital mortality considering the clustering of patients within hospitals.[30] Multicollinearity was determined using variance inflation factors. The statistical significance of the association between health insurance status and in-hospital mortality was assessed via Wald χ^2 test. The area under the receiver operating characteristic curve was used to assess statistical model discrimination. Hosmer-Lemeshow test was conducted to evaluate the statistical significance of differences in the calibration of each model among deciles of the observed and predicted risks.

In view of the problems of overdispersion in the model and the clustered effect of patients within the same hospital, we constructed the multilevel mixed-effects negative binomial regression model to estimate the effects of health insurance status on LOS.[31] The results from this model are in the form of log ratios between the variable and reference groups, which is known as the incidence rate ratio (IRR).

Categorical variables are presented as percentages and continuous variables as means ± standard deviation. The odds ratios (OR) with a 95% confidence interval (CI) and IRRs with a 95% CI are reported as the results of logistic regression models and negative binomial regression models, respectively. *P* values are two tailed. $P < 0.05$ was considered statistically significant. All analyses were performed in R software version 3.2.2 and Stata version 14.0 (Stata Crop, College Station, TX).

RESULTS

Patient and hospital characteristics

In this study, we identified 22,392 patients with AMI, 8,056 patients with HF, and 17,161 patients with pneumonia. The frequencies of patient and hospital characteristics stratified on the basis of health insurance status are listed in Table 1. Patients with UEBMI (39%) and NCMS (43%) represented the largest health insurance group for AMI, HF (UEBMI: 40%, NCMS: 42%), and pneumonia (UEBMI: 50%, NCMS: 32%). Male gender was the most common characteristic in all of the health insurance groups. Under each condition, the patients in the NCMS group were younger and more likely to be admitted under emergent conditions when they had

AMI (34%) and HF (21%) than the patients in the UEBMI group ($P<0.001$). For patients with AMI, 50% were admitted through outpatient medical services and 48% through emergency medical services. Meanwhile, this hospitalization pattern was similar in HF (77% and 21%, respectively) and pneumonia (69% and 22%, respectively). Under each condition, the Charlson comorbidity index of the patients with NCMS was lower than that of the UEBMI patients ($P<0.001$). A majority of the patients in the self-payment group also received health care in hospitals with high bed capacity, and a large proportion of patients sought health care in hospitals located in the middle area of Shanxi.

Table 1. Patient and hospital characteristics, according to medical condition and condition-specific health insurance status.

Variable	Acute Myocardial Infarction						Heart Failure						Pneumonia					
	All patients	Insurance Status					All patients	Insurance Status					All patients	Insurance Status				
		UEBMI	URBMI	NCMS	Self-payment	*P*		UEBMI	URBMI	NCMS	Self-payment	*P*		UEBMI	URBMI	NCMS	Self-payment	*P*
Patient characteristics																		
No. of Patients(%)	22392(100.0)	8664(38.7)	1494(6.7)	9656(43.1)	2578(11.5)		8056(100.0)	3239(40.2)	721(9.0)	3395(42.1)	701(8.7)		17161(100.0)	8540(49.8)	1273(7.4)	5459(31.8)	1889(11.0)	
Age — year	61.3±12.6	63.0±12.8	63.7±13.3	59.6±11.8	60±13.2	<0.001	67.5±13.1	69.9±12.2	69.3±13.5	65.0±12.9	66.6±15.3	<0.001	64.3±16.7	66.8±15.5	65.1±19.2	61.0±16.1	62.0±19.4	<0.001
Female (%)	5614(25.1)	1439(16.6)	709(47.5)	2821(29.2)	645(25.0)	<0.001	3794(47.1)	1038(32.0)	514(71.3)	1888(55.6)	354(50.5)	<0.001	6811(39.7)	2648(31.0)	824(64.7)	2511(46.0)	828(43.8)	<0.001
Admission source(%)						<0.001						<0.001						<0.001
Outpatient medical services	11207(50.0)	4151(47.9)	655(43.8)	5123(53.1)	1278(49.6)		6221(77.2)	2507(77.4)	530(73.5)	2709(79.8)	475(67.8)		118318(68.9)	5854(68.5)	844(66.3)	3999(73.3)	1134(60.0)	
Emergency medical services	10664(47.6)	4277(49.4)	811(54.3)	4331(44.9)	1245(48.3)		1695(21.0)	659(20.3)	185(25.7)	635(18.7)	216(30.8)		3849(22.4)	1966(23.0)	338(26.6)	1050(19.2)	495(26.2)	
Referral	245(1.1)	84(1.0)	11(0.7)	123(1.3)	27(1.0)		15(0.2)	5(0.2)	1(0.1)	7(0.2)	2(0.3)		1119(6.5)	502(5.9)	72(5.7)	338(6.2)	207(11.0)	
Others	276(1.2)	152(1.8)	17(1.1)	79(0.8)	28(1.1)		125(1.6)	68(2.1)	5(0.7)	44(1.3)	8(1.1)		362(2.1)	218(2.6)	19(1.5)	72(1.3)	53(2.8)	
Admission condition(%)						<0.001						<0.001						<0.001
Regular	11337(50.6)	4279(49.4)	747(50.0)	4971(51.5)	1340(52)		6124(76.0)	2490(76.9)	549(76.1)	2556(75.3)	529(75.5)		13658(79.6)	6785(79.5)	1012(79.5)	4388(80.4)	1473(78.0)	
Emergency	6682(29.8)	2492(28.8)	421(28.2)	3266(33.8)	503(19.5)		1474(18.3)	538(16.6)	124(17.2)	702(20.7)	110(15.7)		2255(13.1)	1138(13.3)	166(13.0)	724(13.3)	227(12.0)	
Urgent	4373(19.5)	1893(21.8)	326(21.8)	1419(14.7)	735(28.5)		458(5.7)	211(6.5)	48(6.7)	137(4.0)	62(8.8)		1248(7.3)	617(7.2)	95(7.5)	347(6.4)	189(10.0)	
Charlson Comorbidity Index	3.9±1.9	4.2±1.9	4.4±2.0	3.7±1.7	3.6±1.9	<0.001	4.8±1.9	5.2±1.9	4.9±1.9	4.5±1.8	4.9±2.2	<0.001	3.9±2.2	4.2±2.2	4.0±2.3	3.5±2.1	3.7±2.5	<0.001
Hospital characteristics																		
Hospital beds	1145.4±363.8	1155.3±355.3	1087.5±332.8	1123.8±383.6	1226.4±315.3	<0.001	1032.8±325.4	1077.9±312.3	1019.3±310.9	969.4±332.1	1145.1±302.1	<0.001	1199.7±382.3	1227.6±368.4	1163.1±378.8	1129.7±413.6	1300.2±308.2	<0.001
Number of nurses per 100 beds	65.9±13.0	64.2±12.8	63.4±12.8	68.1±64.9	64.9±12.2	<0.001	35.1±15.0	36.2±14.8	37.1±14.9	33.9±15.4	33.4±12.7	<0.001	32.8±11.5	33.2±11.2	34.4±11.6	32.3±12.5	31.6±9.9	<0.001
Number of doctors per 100 beds	41.8±7.9	41.5±7.9	42.1±7.6	42.5±8.1	40.2±6.7	<0.001	36.8±9.0	37.2±8.6	37.4±10.1	36.5±9.1	36.1±8.6	<0.001	36.1±8.7	36.5±8.3	36.3±9.4	35.4±9.1	36.4±8.6	<0.001
Hospital volume (%)						<0.001						<0.001						<0.001
Below median	11823(52.8)	4956(57.2)	977(65.4)	4978(51.6)	912(35.4)		4054(50.3)	1755(54.2)	375(52.0)	1657(48.8)	267(38.1)		8466(49.3)	3560(41.7)	687(54.0)	3519(64.5)	700(37.1)	
Above median	10569(47.2)	3708(42.8)	517(34.6)	4678(48.4)	1666(64.6)		4002(49.7)	1484(45.8)	346(48.0)	1738(51.2)	434(61.9)		8695(50.7)	4980(58.3)	586(46.0)	1940(35.5)	1189(62.9)	
Hospital region (%)						<0.001						<0.001						<0.001
North	3770(16.8)	1533(17.7)	216(14.5)	1231(12.7)	790(30.6)		1768(22.0)	861(26.6)	133(18.4)	462(13.6)	312(44.5)		3084(18.0)	1530(17.9)	163(12.8)	716(13.1)	675(35.7)	
South	8839(39.5)	2645(30.5)	500(33.5)	4999(51.8)	695(27.0)		2774(34.4)	818(25.2)	221(30.7)	1577(46.5)	158(22.5)		4446(25.9)	1587(18.6)	323(25.4)	2177(39.9)	359(19.0)	
Middle	9783(43.7)	4486(51.8)	778(52.1)	3426(35.5)	1093(42.4)		3514(43.6)	1560(48.2)	367(50.9)	1356(39.9)	231(33.0)		9631(56.1)	5423(63.5)	787(61.8)	2566(47.0)	855(45.3)	

UEBMI, the urban employee-based basic medical insurance; URBMI, urban resident-based basic medical insurance scheme; NCMS, the rural new cooperative medical scheme.

Plus-minus values are means ± standard deviation. Percentages may not total 100 because of rounding.

Unadjusted outcomes

Table 2 presents the unadjusted outcomes of the health insurance groups. The overall in-hospital mortality rates for AMI, HF, and pneumonia were 4.0%, 3.4%, and 7.7%, respectively. In-hospital mortality following pneumonia was highest for NCMS (11.1%) and URBMI (9.1%) patients. Under each condition, the NCMS patients incurred the highest unadjusted in-hospital mortality (4.7%, 4.4%, and 11.1% for AMI, HF, and pneumonia, respectively) among all health insurance groups (P<0.001), while UEBMI patients yielded the lowest unadjusted in-hospital mortality (3.1%, 2.4%, and 5.7% for AMI, HF, and pneumonia, respectively) (P<0.001).

The mean LOS for AMI, HF, and pneumonia were 11.7±6.6 days, 10.5±6.2 days, and 13.0±9.4 days, respectively. Under each condition, the patients in the UEBMI group conferred the longest unadjusted mean LOS (12.5±7.8 days, 11.6±6.3 days, and 13.9±9.9 days for AMI, HF, and pneumonia, respectively) among all the health insurance groups followed by URBMI group

Table 2 Unadjusted outcomes for all patients with acute myocardial infarction, heart failure, and pneumonia by health insurance status.

Outcome	UEBMI	URBMI	NCMS	Self-payment	*P*
Acute Myocardial Infarction					
In-hospital mortality	3.1%	4.4%	4.7%	4.2%	<0.001
Length of stay (days)	12.5±7.8	12.1±6.1	11.2±5.6	10.6±6.0	<0.001
Heart Failure					
In-hospital mortality	2.4%	2.8%	4.4%	3.9%	<0.001
Length of stay (days)	11.6±6.3	10.3±5.5	9.6±6.1	10.0±6.3	<0.001
Pneumonia					
In-hospital mortality	5.7%	9.1%	11.1%	5.7%	<0.001
Length of stay (days)	13.9±9.9	13.1±9.5	11.9±8.0	11.9±10.5	<0.001

UEBMI, the urban employee-based basic medical insurance; URBMI, urban resident-based basic medical insurance scheme; NCMS, the rural new cooperative medical scheme.

Adjusted outcomes for the effect of health insurance status

Table 3 shows the results of multilevel multivariable analyses of the relationship between health insurance status and in-hospital mortality and LOS after patient- and hospital-level covariates were controlled.

Table 3 Adjusted outcomes for the effect of health insurance status among patients with acute myocardial infraction, heart failure, and pneumonia.

Outcome	UEBMI	URBMI	NCMS	Self-payment	AUC
Acute Myocardial Infarction					
In-hospital mortality	1.0	1.22 (0.91-1.63)	1.39 (1.17-1.66)***	1.69 (1.31-2.20)***	0.80
Length of stay(days)	1.0	0.96 (0.93-0.98)***	0.90 (0.89-0.92)***	0.85 (0.83-0.87)***	-
Heart Failure					
In-hospital mortality	1.0	1.31 (0.76-2.27)	1.93 (1.37-2.74)***	1.38 (0.84-2.27)	0.82
Length of stay(days)	1.0	0.90 (0.87-0.94)***	0.85 (0.82-0.87)***	0.87 (0.84-0.91)***	-
Pneumonia					
In-hospital mortality	1.0	1.64 (1.29-2.10)***	1.97 (1.69-2.30)***	1.48 (1.17-1.87)***	0.83
Length of stay(days)	1.0	0.95 (0.92-0.99)***	0.87 (0.85-0.89)***	0.88 (0.85-0.90)***	-

UEBMI, the urban employee-based basic medical insurance; URBMI, urban resident-based basic medical insurance scheme; NCMS, the rural new cooperative medical scheme; AUC, area under receiver operator curve.

$^{*}P<0.1$, $^{**}P<0.05$, $^{***}P<0.01$. In-hospital mortality reported as adjusted odds ratio (95% confidence interval). Length of stay reported as incidence rate ratio (95% confidence interval). Reference group: UEBMI. Outcomes adjusted for patient age, gender, health insurance status, admission source, admission condition, Charlson comorbidity index, hospital volume, number of hospital beds (per increases 100 beds), number of nurses per 100 beds, number of doctors per 100 beds, and hospital geographic region.

Adjusted in-hospital mortality among AMI patients was significantly higher for NCMS (adjusted OR of 1.39, 95% CI=1.17–1.66) and self-payment (OR=1.69, 95% CI= 1.31–2.20), was significantly higher for NCMS among HF patients (OR=1.93, 95% CI=1.37–2.74), and was significantly higher for URBMI (OR=1.64, 95% CI= 1.29–2.10), NCMS (OR=1.97, 95% CI= 1.69–2.30), and self-payment among pneumonia patients (OR=1.48, 95% CI= 1.17–1.87) compared with the UEBMI patients. In addition, the results of multilevel mixed-effects negative binomial regression models similarly demonstrated that the LOS of URBMI, NCMS, and self-payment groups under each condition was significantly shorter than that of the UEBMI group (*P*<0.001). For example, after the patient and hospital characteristics were adjusted in the cases of AMI, our model suggested that the patients in NCMS stayed approximately 90% of the time in the hospital compared with the patients in UEBMI.

DISCUSSION

This study sought practical evidence to determine whether there are insurance-related differences in health outcomes using administrative data from 31 tertiary hospitals in Shanxi, China, focusing on AMI, HF, and pneumonia. Health insurance status is associated with in-hospital mortality and LOS, even after controlling for patient- and hospital-level covariates. Our results suggested that patients with NCMS have significantly higher risk-adjusted in-hospital mortality and shorter LOS in all three conditions than patients with UEBMI, although the association between insurance status and in-hospital mortality and LOS varied by diseases in this study.

The impact of health insurance status on health outcomes in China is a recent focus of research. Our results of patients with AMI are consistent with the findings of Liu et al.[11] Furthermore, our study expanded the limited literature on insurance-related disparities in China in several aspects. First, a broad population comprising patients with AMI, HF, and pneumonia was included in our study and thus helped us examine the effects of health insurance status on health outcomes under diverse medical conditions within a large population. Second, the hospital data we used in this study were within 2014-2015, which could reflect the situation several years later since China launched its new health-care reform in 2009. Third, given the cluster effects, we applied the multilevel mixed-effects logistic regression model and the multilevel mixed-effects negative binomial regression model to quantify the effects of health insurance status on in-hospital mortality and LOS, respectively. Thus, these models could provide a more exact estimation than conventional logistic regression and linear regression model.

In view of the disparities across health insurance groups, a key question emerges: why are there disparities in health outcomes across health insurance groups, especially between NCMS and UEBMI?

One possible explanation is the wide gap in financial protections. The financial protection of UEBMI is higher than that of NCMS because of greater financing capacity.[1,32,33] UEBMI has higher financial protection than NCMS, which may encourage people with UEBMI to consume more health-care resource, such as having more hospitalization and longer LOS. An investigation conducted in Zhejiang and Gansu reported that people with UEBMI and URBMI were more likely to seek both inpatient and outpatient care than those with NCMS and with no insurance.[34] In a study conducted by Ma in 2010,[35] medical insurance predicted the LOS of cerebral infarction, and patients in the medical insurance with higher financial supports might be prone to prolong LOS although more treatments were not required. Personal financial situation also matters apart from the financial support from insurance fund. The attendants who are eligible for UEBMI usually have stable jobs as well as high income level,[9] and their payment capacity to high-priced treatments or medications that may improve their health outcomes is stronger than NCMS participants. Furthermore, from the perspective of health providers, they may be vigilant regarding new and expensive treatment forms and even provide different treatments for patients with the same condition but with different insurance status.[36] Patients with higher levels of payments may be given higher priority to receive health-care services.[37]

Another possible explanation is the wide gap in benefit coverage across insurance schemes. As reported by the World Health Organization, the SHI schemes in China vary largely in the following dimensions: breath (percentage of population covered), depth (percentage of health costs covered), and scope (type of health services covered).[38] NCMS covered more population than the UEBMI, but it was inferior in terms of depth and scope, and NCMS participants possess lower reimbursement level and smaller service coverage.[39-41] In 2011, the reimbursement rate of inpatient care for NCMS was 44%, while it was 68% for UEBMI participants.[3] In addition, UEBMI patients have more comprehensive services coverage than NCMS patients, with the expenses of some medical service items reimbursed to patients with UEBMI rather than patients with NCMS. The lower reimbursement level and more limited services coverage mean higher out-of-pocket expenses to patients with NCMS and may influence their choice of treatments and time to surgery, eventually resulting in the significant differences of health outcomes. For instance, dual anti-platelet therapy (DAPT) is an essential therapy for patients who received reperfusion therapy, while it means heavy economic burden to some NCMS patients because of its high cost and low reimbursement percentage.[11] Therefore, DAPT adherence was lower in the NCMS group than that in other health insurance groups, which finally lead to higher in-hospital mortality. Additionally, NCMS patients tend to take medical cost as a priority when they decide whether to receive treatment or not, which may cause treatment delay and eventually affect the prognosis of patients.[11] Other possible explanations, such as the experience of physicians, differences in procedures, education level, and lifestyle, accounting for the differences in health insurance status have been suggested by relevant studies,[42-44] but empirical evidence in China remains insufficient.

Calls for the consolidation of SHI schemes toward an equitable and efficient system have increased in recent years since the SHI schemes were criticized for its fragmentation,[45-47] but the progress of the consolidation is slow. Several provinces or municipalities have piloted the consolidation of these schemes, and some evidence showed that the consolidation contributed to the equitable access to health care and efficiency of the system.[45] In early 2016, the State Council of People's Republic of China promulgated a guideline on the integration of the URBMI and NCMS, which aims to create a unified basic health insurance system. The URBMI and NCMS would be unified in six areas, namely, insurance coverage, insurance finance, payment standard, medicine and medical service item catalog, management of the qualified insurance institutions, and insurance accounting.[48] This policy guideline has promoted the consolidation of SHI schemes in China, which provides an alternative way to narrow the gaps between different insurance programs and improve health equity.

However, the consolidation may take a long process considering the lack of specific matching plans or policies, difficulty in merging administrative institutions and staff, unifying funding level and benefit packages, reforming payment systems, and strengthening information systems.[36-45]

Policy implications

The universal health insurance coverage in China has improved the accessibility to health-care services, but the government has paid little attention to the disparities of health outcomes among health insurances. This study reveals the disparities of in-hospital mortality and LOS across different insurance schemes. We suggest that policies be made to narrow the gaps of insurance benefits for patients with AMI, HF, or pneumonia, such as increasing reimbursement rate for NCMS and URBMI, expanding the service coverage for NCMS and URBMI, and consolidating SHI schemes. On the other hand, policymakers should adjust the reimbursement policies of some expensive treatments according to the results of clinical practice and economic assessment, such as increasing the reimbursement rate of DAPT for AMI patients with NCMS.

Limitations

This study has several limitations. First, although our study suggested the association between health insurance status and health outcomes, we are unable to identify a causal relation because of the cross-sectional research design. Second, the three common conditions we analyzed represent a large proportion of hospitalizations in Shanxi; however, the results of these data were difficult to generalize into the full spectrum of hospitalizations or patients in other levels of hospitals in China. Finally, capturing all potential confounders in our study is difficult although we anticipated many challenges in data collection. Some details on treatment information and individual socioeconomic status that might be related to health outcomes, such as medications, employment, income, and education, were not available to this study. Therefore, these data were not included in our analysis despite such information being an important indicator of health-care quality. However, we collected the patient and hospital characteristics adopted by previous studies in our database as much as possible and used standard and well-accepted risk-adjustment techniques to reduce potential bias from the unmeasured confounders.

Further research

The observed disparities in our study reveal the potential influence of insurance status on health outcomes in inpatient service practices in Shanxi, China. However, the underlying mechanisms of the association between insurance status and health outcomes are complicated. Further research is necessary to explore the underlying mechanisms and validate this relationship under other diagnoses, such as cardiovascular surgery, orthopedic surgery, and tumor therapy. Moreover, future studies focusing on various dimensions of quality, including process of care and the experience of patients, are warranted.

CONCLUSIONS

Health insurance status is associated with the health outcomes of patients who were hospitalized for AMI, HF, and pneumonia in Shanxi, China. In particular, the adjusted in-hospital mortality rate of NCMS patients was significantly higher, and their LOS was shorter than those of UEBMI patients. Further research should be conducted to understand the mechanisms of the effects of health insurance status on health outcomes to support policy formulation and implementation. Policies also should be considered and formulated by the government to minimize the gaps across different insurance schemes and further improve the equity of health-care delivery in China.

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REFERENCES

1. Yip WC, Hsiao WC, Chen W, *et al*. Early appraisal of China's huge and complex health-care reforms. *Lancet* 2012;379:833-42.
2. Tang S, Brixi H, Bekedam H. Advancing universal coverage of healthcare in China: translating political will into policy and practice. *Int J Health Plann Manage* 2014;29:160-74.
3. Meng Q, Xu L, Zhang Y. Trends in access to health services and financial protection in China between 2003 and 2011: a cross-sectional study. *Lancet* 2012;379:805-14.
4. Liang L, Langenbrunner J. *The long march to universal coverage: lessons from China*. Washington, DC: World Bank 2013:5.
5. Dong K. Medical insurance system evolution in China. *China Econ Rev* 2009;20:591-7.
6. National Health and Family Planning Commission of the People's Republic of China. *2016 China statistical yearbook of health and family planning*. Beijing: Peking Union Medical College Press, 2016.
7. Department of Population and Employment Statistics of National Bureau of Statistics, Department of Planning and Finance of Ministry of Human Resource and Social Security. *China Labour Statistical Yearbook 2015*. Beijing: China Statistics Press, 2015.
8. Sun Y, Gregersen H, Yuan W. Chinese health care system and clinical epidemiology. *Clinical Epidemiology* 2017;9:167–78.

9. Liu X, Wong H, Liu K. Outcome-based health equity across different social health insurance schemes for the elderly in China. *BMC Health Serv Res* 2015;16:1-12.

10. Yu B. Influences of health insurance status on clinical treatments and outcomes for 4,714 patients after acute myocardial infarction in 14 Chinese general hospitals. *J Med Dent Sci* 2005;52:143-51.

11. Liu B, Yan H, Guo R, *et al*. The basic social medical insurance is associated with clinical outcomes in the patients with st-elevation myocardial infarction: a retrospective study from Shanghai, China. *Int J Med Sci* 2014;11:905-17.

12. Wang Z, Zhang Y, Xiong F, *et al*. Association between medical insurance type and survival in patients undergoing peritoneal dialysis. *BMC Nephrol* 2015;16:33.

13. Kong Y, Wang Y, Zhang JH, *et al*. Disparities in medical expenditure and outcomes among patients with intracranial hemorrhage associated with different insurance statuses in southwestern China. *Acta Neurochir Suppl* 2011;111:337-41.

14. Feng Y, Xiong X, Xue Q, *et al*. The impact of medical insurance policies on the hospitalization services utilization of people with schizophrenia: A case study in Changsha, China. *Pak J Med Sci* 2013;29:793-8.

15. Fang H, Meng Q, Rizzo JA. Do different health insurance plans in China create disparities in health care utilization and expenditures? *International Journal of Applied Economics*. 2014;11:1-18.

16. The Bureau of Statistics in Shanxi, China. *Shanxi Statistical Yearbook*. Beijing:

China Statistics Press, 2015.

17. National Center for Cardiovascular Disease, China. *Report on cardiovascular disease in China 2015*. Beijing: Encyclopedia of China Publishing House, 2016.

18. Jiang H, Ge J. Epidemiology and clinical management of cardiomyopathies and heart failure in China. *Heart* 2009;95:1727-31.

19. Xu H, Li W, Yang J, *et al*. The China Acute Myocardial Infarction (CAMI) Registry: A national long-term registry-research-education integrated platform for exploring acute myocardial infarction in China. *Am Heart J*. 2016;175:193-222.

20. National Center for Cardiovascular Disease, China. *Report on cardiovascular disease in China 2014.* Beijing: Encyclopedia of China Publishing House, 2015.

21. He J, Gu DF, Wu XG, *et al*. Major causes of death among men and women in China. *New Engl J Med*. 2005;353:1124-34.

22. He L, Chen X. Contentions on the pathogenic spectrum of community-acquired pneumonia and the first experimental application of antibiotic agents. *Chinese Journal of Practical Internal Medicine*. 2007;27:110-3.

23. Hasan O, Orav EJ, Hicks LS. Insurance status and hospital care for myocardial infarction, stroke, and pneumonia. *J Hosp Med* 2010;5:452-9.

24. Kim J, Lee SG, Lee K, *et al*. Impact of health insurance status changes on healthcare utilisation patterns: a longitudinal cohort study in South Korea. *BMJ Open* 2016;6:e9538.

25. LaPar DJ, Bhamidipati CM, Mery CM, *et al*. Primary payer status affects mortality for major surgical operations. *Ann Surg* 2010;252:544-51.

26. Spencer CS, Gaskin DJ, Roberts ET. The quality of care delivered to patients within the same hospital varies by insurance type. *Health Affair* 2013;32:1731-9.

27. Xu Y, Liu Y, Shu T, *et al*. Variations in the quality of care at large public hospitals in Beijing, China: a condition-based outcome approach. *PLoS One* 2015;10:e138948.

28. Quan HD, Sundararajan V, Halfon P, *et al*. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care* 2005;43:1130-9.

29. Charlson ME, Pompei P, Ales KL, *et al*. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 1987;40:373-83.

30. Rice N, Leyland A. Multilevel models: applications to health data. *J Health Serv Res Policy* 1996;1:154-64.

31. Carter EM, Potts HW. Predicting length of stay from an electronic patient record system: a primary total knee replacement example. *BMC Med Inform Decis Mak* 2014;14:26.

32. Liu K, Wu QB, Liu JQ. Examining the association between social health insurance participation and patients' out-of-pocket payments in China: The role of institutional arrangement. *Soc Sci Med* 2014;113:95-103.

33. Yu H. Universal health insurance coverage for 1.3 billion people: What accounts for China's success? *Health Policy*. 2015;119:1145-52.

34. Li X, Zhang W. The impacts of health insurance on health care utilization among

the older people in China. *Soc Sci Med* 2013;85:59-65.

35. Ma Y, Liu Y, Fu HM, *et al*. Evaluation of admission characteristics, hospital length of stay and costs for cerebral infarction in a medium-sized city in China. *Eur J Neurol* 2010;17:1270-6.

36. He AJ, Wu S. Towards universal health coverage via social health insurance in China: Systemic fragmentation, reform imperatives, and policy alternatives. *Appl Health Econ Health Policy* 2016:1-10.

37. Zhong H. Effect of patient reimbursement method on health-care utilization: evidence from China. *Health Econ* 2011;20:1312-29.

38. World Health Organization. Sustainable health financing, universal coverage and social health insurance. World Health Assembly Resolution, 2005, 58.

39. Fu R, Wang Y, Bao H, *et al*. Trend of urban-rural disparities in hospital admissions and medical expenditure in China from 2003 to 2011. *PLoS One* 2014;9:e1085719.

40. Wagstaff A, Lindelow M, Jun G, *et al*. Extending health insurance to the rural population: an impact evaluation of China's new cooperative medical scheme. *J Health Econ* 2009;28:1-19.

41. Barber SL, Yao L. Development and status of health insurance systems in China. *The Int J Health Plann Manage* 2011;26:339-56.

42. Canto JG, Rogers WJ, French WJ, *et al*. Payer status and the utilization of hospital resources in acute myocardial infarction: a report from the National Registry of Myocardial Infarction 2. *Arch Intern Med* 2000;160:817-23.

43. Mainous AGI, Diaz VA, Everett CJ, *et al*. Impact of insurance and hospital ownership on hospital length of stay among patients with ambulatory care–sensitive conditions. *Ann Fam Med* 2011;9:489-95.

44. Lantz PM, House JS, Lepkowski JM, *et al*. Socioeconomic factors, health behaviors, and mortality: results from a nationally representative prospective study of US adults. *JAMA* 1998;279:1703-8.

45. Meng Q, Fang H, Liu X, *et al*. Consolidating the social health insurance schemes in China: towards an equitable and efficient health system. *Lancet* 2015;386:1484-92.

46. Wang H, Liu Z, Zhang Y, *et al*. Integration of current identity-based district-varied health insurance schemes in China: implications and challenges. *Front Med* 2012;6:79-84.

47. Wang X, Zheng A, He X, *et al*. Integration of rural and urban healthcare insurance schemes in China: an empirical research. *BMC Health Serv Res* 2014;14:142.

48. State Council of People's Republic of China. Guideline for integration of basic medical insurance for urban employees and the new rural cooperative medical scheme. 2016. http://www.gov.cn/zhengce/content/2016-01/12/content_10582.htm. (accessed 22 Sep 2016).

Figure legends:

Figure 1 Flowchart of the sampling process. AMI, acute myocardial infarction; HF, heart failure; ICD-10, the international classification of diseases, tenth revision; NCMS, the new cooperative medical scheme; UEBMI, the urban employee-based basic medical insurance; URBMI, the urban resident-based basic medical insurance.

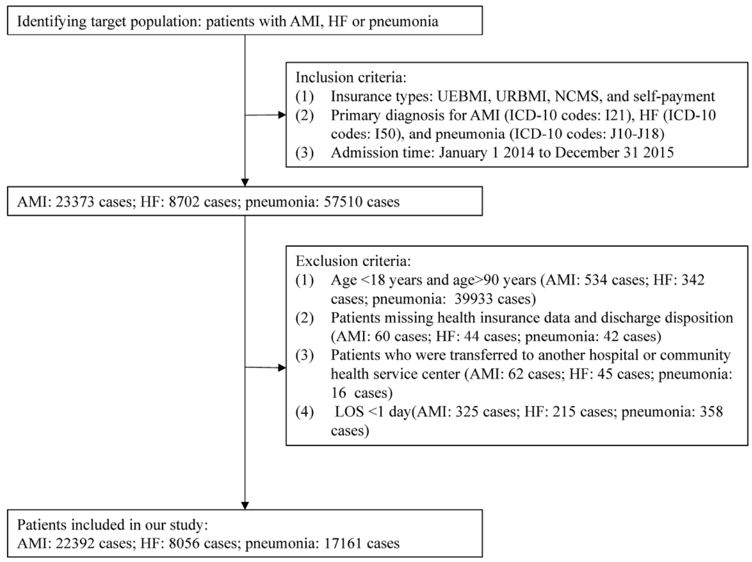

Figure 1 Flowchart of the sampling process. AMI, acute myocardial infarction; HF, heart failure; ICD-10, the international classification of diseases, tenth revision; NCMS, the new cooperative medical scheme; UEBMI, the urban employee-based basic medical insurance; URBMI, the urban resident-based basic medical insurance.

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Supplemental table 1 ICD-10 codes identifying index admissions with acute myocardial infarction, heart failure, and pneumonia

Diseases	ICD-10 codes
Acute Myocardial Infarction	I21.000, I21.001, I21.002, I21.003, I21.004, I21.005, I21.006, I21.007, I21.100, I21.101, I21.102, I21.103, I21.104, I21.105, I21.200, I21.201, I21.202, I21.203, I21.204, I21.205, I21.206, I21.300, I21.301, I21.302, I21.303, I21.400, I21.401, I21.402, I21.900
Heart Failure	I50.000, I50.001, I50.100, I50.900, I50.901, I50.902, I50.903, I50.904, I50.905, I50.906
Pneumonia	J10.000, J10.001, J10.100, J10.101, J10.800, J10.801, J10.802, J11.000, J11.100, J11.101, J11.102, J11.800, J12.000, J12.100, J12.200, J12.800, J12.900, J13.x00, J14.x00, J15.000, J15.001, J15.100, J15.101, J15.102, J15.200, J15.300, J15.400, J15.401, J15.402, J15.500, J15.600, J15.601, J15.602, J15.700, J15.800, J15.900, J15.901, J15.902, J15.903, J16.000, J16.800, J18.000, J18.001, J18.100, J18.200, J18.800, J18.801, J18.900, J18.901, J18.902

ICD-10, the International Classification of Diseases, 10th Revision

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	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	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-8
Objectives	3	State specific objectives, including any prespecified hypotheses	8
Methods			
Study design	4	Present key elements of study design early in the paper	9
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	9
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	10
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	11-12
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	*11-12*
Bias	9	Describe any efforts to address potential sources of bias	12
Study size	10	Explain how the study size was arrived at	11
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	12
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	12-13
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	10-11
		(*e*) Describe any sensitivity analyses	

Continued on next page

Results			Page
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	13-14
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	15
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	*16*
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	16-18
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	18
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	22-23
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	19-21
Generalisability	21	Discuss the generalisability (external validity) of the study results	22-23
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	25

*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.