Policy Spotlight Effect in Critical Time-Sensitive Diseases

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Abstract

Background: Categorization of hospital emergency capability (CHEC) is a policy implemented worldwide to regionalize critical emergent care. The CHEC policy mainly uses time-based indicators as emergency care quality measurements.

Objectives: We aimed to explore the CHEC policy spotlight effect on critical time-sensitive diseases with and without the influence of time-based surveillance indicators and guidelines.

Research Design: We conducted a nationwide retrospective cohort study between 2005–2011. Regarding critical time-sensitive diseases, our study targeted acute ischemic stroke (AIS), ST-segment elevation myocardial infarction (STEMI), septic shock, and major trauma. We selected diagnosis and treatment guideline adherence as process quality measures and defined medical utilization, upward transfer rate, and short-term mortality rate as outcome indicators.

Subjects: The Taiwan National Health Insurance 2005 Longitudinal Health Insurance Database contains one million random cases, including medical records and hospital information.

Results: During this 7-year study AIS, STEMI, septic shock, and major trauma, respectively. AIS and STEMI cohorts had significantly higher rates of guideline adherence and better process quality than those of septic shock and major trauma cohorts. Furthermore, AIS and STEMI cohorts had a significant increase in diagnosis costs.

Conclusion: The CHEC policy spotlight effect exists in critical time-sensitive diseases with time-based quality indicators. Importantly, disease entities without these indicators may experience decreases in diagnosis and treatment guideline adherence, indirectly jeopardizing their outcomes.

Introduction

Emergency care is a symptom-driven profession delivered by emergency department (ED) physicians under significant time pressure and uncertainty [1]. Emergency care providers tentatively diagnose specific diseases based on at least 70 common disease patterns encountered in the ED, often dedicating only 3% of their time for diagnosis [2], despite this step representing the most important in terms of cost [2]. Furthermore, medical care providers are the most influential decision-makers and drive approximately 70%–80% of medical utilization [3].

Critical time-sensitive diseases refer to life-threatening illnesses or injuries that require immediate emergency care. The Agency for Healthcare Research and Quality proposed the concept of time-sensitive diseases[4] using scientific data to maintain up-to-date guidelines and launched the “get with the guidelines” (GWTG) campaign to establish it as the basis for surveillance indicators of process and outcome quality.[5] The guidelines institute specific time-sensitive goals according to the critical disease. In acute ischemic stroke events, the “time is brain” [6] goal focuses on the timely administration of thrombolytic therapy; in ST-segment elevation myocardial infarction (STEMI) events, the “time is muscle” goal focuses on early reperfusion [7]; in septic shock events, the “early goal” focuses on early resuscitation [8]; and in major trauma events, the “golden hour” goal focuses on the window of opportunity in which patients can undergo rescue operations [9].

The American Medical Association issued guidelines for the categorization of hospital emergency capability (CHEC) [10] to classify hospitals according to their emergency care capabilities, thereby providing emergency medical services with references to transport emergent patients to the nearest appropriate hospitals for diagnosis and treatment, aiming to reduce the incidence of preventable deaths. Most studies investigating the effects of this categorization and regionalization policy reported positive findings. However, these studies mostly focused on a single disease entity, hospital, or region.

The CHEC policy often implements rigid time-based surveillance indicators. These indicators can affect disease-specific guideline adherence in clinical practice because they may reshape the behaviors of ED medical providers [11]. This phenomenon is related to the so-called “spotlight effect”, which influences medical care providers’ assessment of how they are perceived by others [12]. More specifically, the “policy spotlight effect” refers to how medical care providers tend to perceive how policymakers interpret surveillance indicators and adjust their process-related behaviors accordingly [13]. Current emergency care policies often use time-based criteria as process quality indicators, which may exacerbate the policy spotlight effect [12]; however, the unintended effects or safety concerns generated by this effect remain unclear.

This study targeted four critical time-sensitive diseases: acute ischemic stroke, STEMI, septic shock, and major trauma [9]. Acute ischemic stroke, STEMI, and septic shock had well-developed structured guidelines while those for major trauma were under constant development owing to the heterogeneity of injury mechanisms, locations, and severity. Moreover, acute ischemic stroke and STEMI events had rigid time-based quality indicators and regular *surveillance under CHEC policy*, whereas septic shock and major trauma events did not (supplementary table 1). Thus, we selected septic shock and major trauma events as external controls for CHEC policy surveillance indicators. With this, our study could evaluate the “policy spotlight effect” influence on clinical practice, investigating whether emergency care providers may unconsciously focus on disease entities under active surveillance and neglect aspects or entities that are not fully contemplated in this monitoring based on their assessment of how observers perceive them [14].

This study aimed to compare critical time-sensitive diseases with and without CHEC policy surveillance indicators based on measures of process quality and outcome indicators to investigate the following research questions: (1) how does CHEC policy surveillance indicators for certain critical time-sensitive diseases affect the process quality regarding diagnoses, treatments, and outcomes? (2) does “policy spotlight effect” exist in this context? and (3) what are the *unintended consequences of the “policy spotlight effect”*?

Methods

Setting

In Taiwan, the CHEC policy was initially implemented in 2007 as a trial comprising the designation and regionalization of emergency rescuer-responsive hospitals and subsequently formally implemented in 2009 [15]. The policy focuses on acute stroke, acute myocardial infarction, major trauma, and critical perinatal conditions at a hospital level, including ED, critical time-sensitive disease care team, and intensive care unit (ICU).

Study design and data source

In this nationwide retrospective cohort study, we examined the circumstances before and after CHEC policy implementation using a comparative approach. The Taiwanese National Health Insurance (NHI) is a single-payer compulsory social insurance system in which the payment system mainly comprises a fee-for-service and a small payment for performance. This study is based on the NHI 2005 Longitudinal Health Insurance Database (LHID2005), which contains one million random cases, including medical records and hospital information, collected since 1995. The study database was verified as a representative sample of the population of Taiwan. The LHID2005 was validated as representative of medical utilization, as well as of diagnosis and treatment process, and outcome quality for critical time-sensitive diseases. Hospital categorization according to emergency care capability and regional emergency care resource classification was accredited by the Taiwan Ministry of Health and Welfare. The study design was approved by the appropriate Institutional Review Board on 5 May 2018. The requirement for informed consent was waived due to the utilization of anonymized patient data.

Identification of study cohort

In this study, critical time-sensitive diseases were identified based on ED visits accompanied by a primary diagnosis using the appropriate disease code. The diagnosis of acute ischemic stroke (codes 433 and 434), STEMI (codes 410 and 429), and septic shock (codes 038, 785, and 995) were based on the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM). Major trauma (codes 800-959) was diagnosed based on the American Academy of Surgery Committee guidelines [16]. Because the LHID2005 database lacks trauma severity information, we supplemented the diagnosis of major trauma using pertinent ICD-9-CM codes, information on rescue surgery, or ICU admission [17]. We excluded cases that occurred prior to the start of the study period and those that lacked hospital or patient's sociodemographic information. We also excluded hospitals that had a volume of critical time-sensitive disease cases lower than five cases per year. We used the date of the first critical time-sensitive disease ED visit as the index date.

Variables

The independent variable was “policy spotlight effect”. Outcome variables included time-sensitive disease guideline adherence rate as a diagnosis and treatment process quality indicator; and upward transfer rate, cost, and short-term mortality as outcome quality indicators. Patients' predisposing factors included age, sex, and other associated factors such as occupational category, insured salary, and Charlson Comorbidity Index (CCI) score one year prior to the index date. External environmental factors included urbanization degree and regional ED resources. The hospital-level control variables were selected based on the study by Asplin et al., including an ED crowding input-throughput-output conceptual model [18] that controls the input according to the rate of hospital ED visits with a triage severity of I and II, while the throughput and output efficiency is evaluated using the observed occupancy rate for ED visits.

We divided the study timeline into three periods: pre-policy intervention (August 1, 2005–July 31, 2007), CHEC trial (August 1, 2007–July 31, 2009), and formal CHEC implementation (August 1, 2009–July 31, 2011). We examined differences in outcome variables according to sex, age, occupation, income, emergency medical resource classification, and CCI. ICD-9-CM codes for principal diagnoses—including inpatient and outpatient NHI claims in the year prior to death—were used to identify comorbidities. The CCI was calculated using ICD-9-CM codes and the scores were categorized as ≤ 1 or ≥ 2 according to these conditions.

Statistical methods

Patients' baseline characteristics, diagnosis and treatment processes, transfer rate, medical utilization, and short-term mortality outcomes were compared and analyzed using descriptive and analytic methods. Outcome variables were analyzed using multivariate logistic regression. The

distribution of covariates across study periods was assessed using the Chi-squared test and t-test. Non-normally distributed continuous data were described using median and the 25th and 75th percentiles (interquartile range). We obtained the contribution of each predictor to the overall explanatory power of the model conducting a subgroup analysis for each stratum of sex, age group, income, living area, occupation, CCI score, and emergency medical resource area using the multivariate logistic regression model without stratification and with one dichotomous independent variable, i.e. whether definite diagnosis and treatment were implemented. Adjusted odds ratios (aOR) with 95% confidence intervals (CI) were obtained using a logistic regression analysis adjusted for risk factors. All analyses were performed using Statistical Analysis Software version 9.4 (SAS Institute Inc., Cary, NC, USA). A p-value <0.05 was considered statistically significant.

Results

Baseline characteristics

Initially, we identified 22,228 ED visits for acute stroke, 7,337 for acute myocardial infarction, 34,577 for septic shock, and 226,301 for major trauma between 2005–2011. After applying the pre-determined exclusion criteria, we included 12,474 ED visits for acute ischemic stroke, 3,622 for STEMI, 23,171 for septic shock, and 4,096 for major trauma in this study (supplementary figure 1). As shown in supplementary table 1, septic shock occurred more frequently than the remaining critical time-sensitive diseases. The proportion of male patients was significantly higher than that of female patients in all cohorts (supplementary table 1). Major trauma cases had a biphasic age distribution in which the age groups ≥ 65 years and ≤ 39 years were the most representative and had significantly lower CCI scores than the remaining age groups. The proportion of manual workers was higher than that of other occupations in all cohorts. Nearly 80% of critical time-sensitive diseases were treated at hospitals categorized as moderate or severe levels. Approximately 20% of patients resided in a region with insufficient emergency care resources.

Principal findings

We observed the CHEC policy implementation impact on the quality of diagnoses, treatments, and short-term mortality outcomes of critical time-sensitive diseases from several perspectives. (1) The proportion of patients with acute ischemic stroke who received diagnostic brain structural imaging examination, intravenous thrombolytic treatment (intravenous tissue plasminogen activator, IV-tPA), antiplatelet drugs usage, diagnosis cost and total cost increased significantly after policy implementation (supplementary tables 3 and 4). Conversely, upward transfer and 30-day mortality rates remained unchanged. (2) The proportion of patients with STEMI as well as the rate of electrocardiography (EKG), percutaneous coronary intervention (PCI), antiplatelet drugs usage and diagnosis cost increased significantly after policy implementation (supplementary tables 5 and 6). Furthermore, the 7-day and 30-day mortality rate decreased significantly after CHEC policy implementation and the upward transfer rate showed a downward trend. Conversely, IV-tPA increase significantly. (3) The proportions of patients with septic shock who diagnosis using bacterial cultures, antipathogen drug administration, diagnosis cost and total cost did not change significantly after policy implementation (supplementary tables 7 and 8). Conversely, the use of lactic acid tests increased while the use of central venous catheters decreased after CHEC policy implementation. The 30-day mortality rate was significantly higher during the trial period than before the policy was implemented. Though not statistically significant, the upward transfer rate decreased after policy implementation. (4) Among major trauma cohort, we also observed a non-significant decrease in total cost, upward transfer, rescue surgery and short-term mortality rates, after treatment policy implementation (supplementary tables 9 and 10). Furthermore, the diagnosis cost decreased significantly after policy implementation.

Multivariate analysis

We used multivariate logistic regression analysis to examine critical time-sensitive diseases' processes and outcomes quality. (1) Compared with the pre-intervention period, treatment of acute ischemic stroke with Aspirin usage and intravenous tissue plasminogen activator thrombolysis significantly increased after policy implementation (aOR, 2.1; 95% CI, 1.2–3.7; $p=0.004$) (table 1). Furthermore, the upward transfer rate increased significantly after policy implementation (supplementary table 11). (2) STEMI diagnosis with EKG had no significant change (aOR, 1.1; 95% CI, 0.9–1.4; $p=0.736$) (table 2). Whereas as treatment with clopidogrel increased significantly after policy implementation (aOR, 2.0; 95% CI, 1.6–2.5; $p<0.001$). Conversely, STEMI treatment with percutaneous coronary intervention did not change (aOR, 1.1; 95% CI, 0.9–1.4; $p=0.736$). The short-term mortality rate in both acute ischemic stroke and STEMI cohorts did not differ significantly pre- and post-intervention (supplementary tables 11 and 12). (3) Septic shock diagnosis with blood culture (aOR, 0.8; 95% CI, 0.7–1.0; $p=0.002$), both diagnosis and treatment with central venous catheter (aOR, 0.7; 95% CI, 0.7–0.8; $p<0.001$) and use of antibiotics (aOR, 0.8; 95% CI, 0.7–0.9; $p<0.001$) decreased significantly after policy implementation (table 4). Nevertheless, diagnosis with lactic acid test increased significantly during the trial period (aOR, 1.3; 95% CI, 1.2–1.5; $p<0.0001$). Furthermore, the 30-day mortality rate increased significantly during the trial period (aOR, 1.2; 95% CI, 1.1–1.3; $p<0.001$) and maintained an increasing trend after policy implementation (aOR, 1.0; 95% CI, 0.9–1.1; $p=0.060$) (supplementary tables 13). (4) Major trauma treatment with rescue surgery decreased significantly after policy implementation (aOR, 0.8; 95% CI, 0.6–0.9; $p<0.017$) (table 4), yet, the upward transferred rate increased significantly after policy implementation (supplementary tables 14). Furthermore, the short-term mortality rate did not differ significantly pre- and post-intervention.

Sensitivity analysis

In order to test the length of stay effect over diagnosis, treatment and outcome characteristics of time-sensitive disease. We adjusted length of stay in acute ischemic stroke cohort. The diagnosis, treatment and outcome of acute stroke patients did not differ significantly pre- and post-intervention (supplementary table 15).

Discussion

Methodology and principal findings

Our findings indicated that the implementation of CHEC policy resulted in improved treatment guideline adherence rates and process quality for both acute ischemic stroke and STEMI cohorts. In contrast, the lack of surveillance indicators for septic shock and major trauma may have resulted in a decrease in process quality, indirectly worsening the septic shock short-term mortality rate. Furthermore, all disease cohorts significantly increased their diagnosis-related costs without significant benefits to short-term mortality outcomes (table 5).

According to the Veterans Administration Quality Enhancement Research Initiative (QUERI), provider behaviour include external environment, organization practice, patient encounters, and clinical conditions [11]. Accordingly, our findings demonstrated that the implementation of CHEC policy—a factor that altered the external environment—affected emergency care providers' behaviors when managing critical time-sensitive diseases. The CHEC policy improves emergency care capability and guideline adherence rates, generally increasing diagnosis and treatment quality and decreasing upward transfer rates. Previous studies evaluating the regionalization [19] and categorization [20] effects of CHEC policy often reported substantially positive findings. However, when comparing different critical time-sensitive conditions, we observe that emergency care providers under time pressure and with different levels of guideline adherence may alter their behaviour in a way that increases diagnosis costs and decreases the time spent on time-consuming process management activities.

In Taiwan, the nationwide CHEC policy implementation was akin to a natural experiment without randomization. In this study, we explored the influence of the policy spotlight effect on diseases with time-based quality indicators and its possible unintended consequences. To distinguish medical care providers' behaviors under the Hawthorne effect or policy spotlight effect, we selected acute ischemic stroke and STEMI as critical time-sensitive diseases with well-developed guidelines and time-based quality indicators under CHEC policy. As external controls, we selected septic shock as a disease with well-developed guidelines but no specific quality indicators and major trauma as a disease without well-developed guidelines and specific quality indicators. Based on these natural experimental conditions, we hypothesize that the Hawthorne effect's response reaction may explain the different levels of awareness of emergency care providers [21]. Hawthorne experiments demonstrated that emergency care providers under policy interventions increased their health care guideline adherence rates and productivity [22]. Regarding process quality aspects, policy interventions resulted in a decrease in transfer rates and an increase in medical utilization. Furthermore, time constraints and ambiguous symptom patterns in addition to time-based quality surveillance indicators may exacerbate the policy spotlight effect, further explaining how emergency care providers unconsciously adopt selective behaviors focusing on certain disease entities according to policy targets. Consequently, disease entities that are not the focus of the policy—such as septic shock and major trauma in this study—may experience a significant decrease in process quality. The safety concerns that may arise from this unintended consequence is exemplified by the increase in septic shock short-term mortality rates after CHEC policy implementation.

Currently, many emergency care policies implement time-based criteria [23-25], such as the UK's 4-hour standard [25] and "four-hour rule" [23]. Australia's experience shows that an emergency care policy using time-based criteria can improve emergency congestion without increasing the rate of ED re-visit. In New Zealand, a policy in effect during 2006–2012 dictated that emergent patients must be hospitalized, referred, or discharged within six hours of visiting the ED. After emergency care policy intervention, the length of ED stay decreased while the treatment outcomes of acute myocardial infarction, severe septic shock, and acute appendicitis did not improve significantly.[24] Similarly, after the Canadian Emergency Observation Reduction Program implementation, the length of ED stay decreased while the treatment quality indicators for acute myocardial infarction, asthma, and upper limb fractures can only be treated in time for the above-mentioned time-sensitive diseases during the non-congested emergency period [26].

Apart from the policy spotlight effect, our study provided new evidence indicating that time-based quality indicators may not represent effective and efficient surrogates for emergency care indicators. Emergency care quality is closely related to the practices of medical care providers [11]. Policymakers and medical care providers must not only place the "spotlight" on time-based process indicators but also develop new dimensions of evaluation criteria for emergency care quality to avoid unintended consequences to disease entities out of the spotlight. Therefore, we suggest that time-based process indicators should be replaced with performance indicators such as the NHS's payment for "Best Practice Tariff" policy [27] because emergency care providers often manage unclassified and ambiguous time-sensitive diseases [28]. Suppose quality evaluation of emergency care policies continues to focus on time-based indicators. In that case, medical negligence may become the emergency care provider's primary concern, consequently shifting their behavior to a diagnosis-based practice [29]. Further, excessive use of diagnostic tests may worsen ED crowding, leading to a deterioration of emergency care quality and an increase in safety issues [30].

Strength

To the best of our knowledge, this was the first nationwide retrospective cohort study using data on different critical time-sensitive diseases and following the QUERI framework [11] to explore emergency care providers' behaviors under time constraints and how they interacted with strict time-based quality surveillance indicators and GWTG adherence. Our study explored a new paradigm in emergency care provider's behavior research. Our findings applied the concept of Hawthorne's effect to the policy spotlight effect and its unintended consequences.

Limitations

Because the study data were retrieved from a secondary dataset of insurance claims not a randomized controlled trial, this study has the following limitations: (1) our analysis lacked detailed information on time-related quality indicators, such as door-to-evaluation and door-to-treatment times; (2) we only assessed short-term CHEC policy effects, which may not reflect its long-term impact on emergency care quality, to prevent the interference of other emergency care policies; (3) we need more qualitative research to elucidate the psychological mechanisms through which the policy spotlight effect influences emergency care providers' behaviour; and (4) future qualitative research studies should focus on the well-being of emergency care providers to compensate for quantitative research inadequacies.

In conclusion, our study used real-world evidence to demonstrate that CHEC policy implementation generated a policy spotlight effect resulting in a disproportional improvement in disease guideline adherence rates and process quality of critical time-sensitive diseases with time-based surveillance indicators. In contrast, disease entities not fully encompassed in the surveillance may be jeopardized with a decrease in diagnosis and treatment processes, indirectly worsening the quality of outcomes.

Abbreviations

AHRQ: Agency for Healthcare Research and Quality; CCI: Charlson Comorbidity Index; CHEC policy: Categorization hospital emergency capability policy; CVC: central venous catheter; ED: emergency department; EKG: Electrocardiography; ICU: intensive care; IQR: interquartile range; IV-tPA: intravenous tissue plasminogen activator; LHID2005: 2005 Longitudinal Health Insurance Database; MI: myocardial infarction; MoHW: Ministry of Health and Welfare; NA: not applicable; NHI: National Health Insurance; PCI: Percutaneous coronary intervention; STEMI: ST-segment elevation myocardial infarction

Declarations

Ethics Approval and Consent to Participate

This study approved by Institutional Review Board of National Yang-Ming University-YM107035E on May, 5 2018. In accordance with regulations of the National Health Research Institutes, patient identification information was anonymized, such that informed consent was not required.

Availability of Data and Materials

The data that support the findings of this study are available from the Taiwan National Health Insurance Research Database, but restrictions apply to the availability of these data, which were used under license for the current study and so are not publicly available. Data are however available from the authors upon academic request and with permission of the Taiwan National Health Insurance Administration.

Competing Interests

The authors declare that they have no competing interests.

Funding

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Authors' Contributions

C-YL, L-CL, and Y-CL made substantial contributions to conception and design of this study. C-YL analysis and interpretation of data, and preparation of the manuscript. L-CC and Y-CL critical appraisal and rewrite the manuscript to become an academic research paper. All authors have read and approved the manuscript. There are no conflicts of interest to declare.

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Tables

Due to technical limitations, table 1 is only available as a download in the Supplemental Files section.

Table 2 The diagnosis and treatment multivariate logistic regression analysis of ST-segment elevation MI patients

	Clopidogrel			Aspirin			EKG			PCI		
	OR	95% CI	P-value	OR	95% CI	P-value	OR	95% CI	P-value	OR	95% CI	P-value
Sex												
Female	1	Ref		1	Ref		1	Ref		1	Ref	
Male	1.2	(1.0-1.4)	0.028	1.3	(1.1-1.5)	0.006	1.0	(0.8-1.4)	0.714	1.3	(1.1-1.5)	0.008
Age												
≤ 39	1	Ref		1	Ref		1	Ref		1	Ref	
40-54	2.9	(1.8-4.4)	<0.001	3.3	(2.1-5.1)	<0.001	2.3	(1.3-4.2)	0.054	1.9	(1.2-2.9)	0.001
55-64	2.8	(1.8-4.4)	<0.001	3.0	(2.0-4.7)	0.001	2.3	(1.3-4.3)	0.041	1.9	(1.2-3.0)	<0.001
≥ 65	2.3	(1.5-3.5)	0.263	2.6	(1.7-3.9)	0.087	1.8	(1.0-3.2)	0.914	1.1	(0.7-1.7)	0.001
Charlson Comorbidity Index												
≤ 1	1	Ref		1	Ref	.	1	Ref	.	1	Ref	.
≥ 2	0.8	(0.7-1.0)	0.011	0.7	(0.6-0.8)	<0.001	1.0	(0.8-1.2)	0.734	0.6	(0.5-0.7)	<0.001
Income level												
Quantile 1(Lowest)	1	Ref		1	Ref		1	Ref		1	Ref	
Quantile 2	1.1	(0.9-1.5)	0.604	1.3	(1.0-1.8)	0.333	1.2	(0.8-1.9)	0.372	1.1	(0.8-1.5)	0.707
Quantile 3	1.0	(0.7-1.3)	0.333	1.2	(0.8-1.6)	0.698	0.9	(0.6-1.5)	0.288	1.2	(0.8-1.7)	0.726
Quantile 4	1.0	(0.8-1.4)	0.643	1.3	(1.0-1.8)	0.353	1.1	(0.7-1.7)	0.866	1.1	(0.8-1.5)	0.622
Quantile 5(Highest)	1.3	(1.0-1.7)	0.047	1.3	(1.0-1.8)	0.377	1.2	(0.8-1.9)	0.335	1.3	(1.0-1.8)	0.053
Occupation												
Dependents of the insured individuals	1	Ref		1	Ref		1	Ref		1	Ref	
Civil servants, teachers, military personnel, and veterans	0.8	(0.6-1.1)	0.060	0.9	(0.7-1.2)	0.291	0.7	(0.5-1.1)	0.325	0.8	(0.6-1.1)	0.270
Nonmanual workers and professionals	1.3	(1.0-1.8)	0.032	1.7	(1.2-2.4)	<0.001	1.0	(0.6-1.6)	0.518	1.0	(0.7-1.3)	0.413
Manual workers	0.9	(0.8-1.2)	0.385	0.9	(0.7-1.1)	0.159	0.8	(0.6-1.2)	0.736	0.9	(0.7-1.1)	0.847
Others	1.0	(0.8-1.4)	0.735	0.8	(0.6-1.1)	0.043	0.8	(0.5-1.2)	0.673	0.9	(0.6-1.1)	0.627
Hospital categorization[§]												
Severe	3.2	(2.4-4.3)	<0.001	1.7	(1.3-2.3)	0.235	2.8	(1.7-4.6)	<0.001	4.2	(3.0-5.8)	<0.001

	Clopidogrel			Aspirin			EKG			PCI		
	OR	95% CI	P-value	OR	95% CI	P-value	OR	95% CI	P-value	OR	95% CI	P-value
Moderate	3.3	(2.7-4.1)	<0.001	2.2	(1.8-2.7)	<0.001	1.4	(1.0-2.0)	0.298	3.4	(2.6-4.3)	<0.001
General	1	Ref		1	Ref		1	Ref		1	Ref	
ED triage severity rate	1.0	(1.0-1.0)	0.024	1.0	(1.0-1.0)	0.258	1.0	(1.0-1.0)	0.001	1.0	(1.0-1.0)	<0.001
ED observation rate	1.0	(1.0-1.0)	<0.001	1.0	(1.0-1.0)	0.004	1.0	(1.0-1.0)	0.030	1.0	(1.0-1.0)	0.383
Place of ED resources												
Sufficiency	1	Ref		1	Ref		1	Ref		1	Ref	
Not sufficiency	1.0	(0.8-1.2)	0.791	1.0	(0.8-1.2)	0.683	0.9	(0.7-1.3)	0.675	1.1	(0.9-1.3)	0.372
Policy stage												
Pre-policy intervention	1	Ref		1	Ref		1	Ref		1	Ref	
Trial of categorization	1.4	(1.2-1.8)	0.930	1.0	(0.8-1.2)	0.238	1.1	(0.8-1.6)	0.351	1.2	(0.9-1.5)	0.230
Categorization policy	2.0	(1.6-2.5)	<0.001	1.2	(0.9-1.5)	0.081	1.0	(0.7-1.5)	0.689	1.1	(0.9-1.4)	0.736

ED: emergent department; EKG: Electrocardiography; MI: myocardial infarction; OR: odds ratio; PCI: Percutaneous coronary intervention

Table 3 The diagnosis and treatment multivariate logistic regression analysis of septic shock patients

	Blood culture			Central venous catheter			Lactic acid			Antibiotics		
	OR	95% CI	P-value	OR	95% CI	P-value	OR	95% CI	P-value	OR	95% CI	P-value
Sex												
Female	1	Ref		1	Ref		1	Ref				
Male	1.1	(1.0-1.2)	0.047	1.3	(1.2-1.4)	<0.001	1.2	(1.1-1.3)	<0.001	0.9	(0.9-1.0)	0.011
Age												
≤ 39	1	Ref		1	Ref		1	Ref				
40-54	1.2	(1.0-1.3)	0.036	1.9	(1.7-2.2)	0.012	1.4	(1.1-1.6)	0.279	1.4	(1.2-1.6)	0.600
55-64	1.4	(1.2-1.6)	0.156	1.9	(1.6-2.2)	0.108	1.6	(1.4-2.0)	0.005	1.5	(1.3-1.7)	0.005
≥ 65	1.7	(1.5-1.9)	<0.001	2.6	(2.3-3.0)	<0.001	1.9	(1.7-2.3)	<0.001	1.7	(1.5-1.8)	<0.001
Charlson Comorbidity Index												
≤ 1	1	Ref		1	Ref		1	Ref				
≥ 2	1.6	(1.5-1.8)	<0.001	1.9	(1.7-2.0)	<0.001	1.4	(1.3-1.5)	<0.001	1.2	(1.2-1.3)	<0.001
Income level												
Quantile 1 (Lowest)	1	Ref		1	Ref		1	Ref		1	Ref	
Quantile 2	1.0	(0.9-1.2)	0.844	0.8	(0.7-0.9)	0.687	1.1	(0.9-1.3)	0.147	1.0	(0.9-1.1)	0.963
Quantile 3	1.2	(1.0-1.4)	0.018	0.8	(0.7-0.9)	0.951	1.0	(0.9-1.2)	0.846	1.1	(1.0-1.2)	0.136
Quantile 4	1.0	(0.8-1.2)	0.566	0.7	(0.7-0.9)	0.003	1.0	(0.9-1.2)	0.909	1.1	(0.9-1.2)	0.298
Quantile 5 (Highest)	1.0	(0.8-1.1)	0.181	0.8	(0.7-0.9)	0.164	1.0	(0.8-1.1)	0.132	0.9	(0.8-1.0)	0.016
Occupation												
Dependents of the insured individuals	1	Ref		1	Ref		1	Ref		1	Ref	
Civil servants, teachers, military personnel, and veterans	1.1	(0.9-1.3)	0.413	1.0	(0.9-1.1)	0.950	0.9	(0.8-1.0)	0.253	0.9	(0.8-1.0)	0.002
Nonmanual workers and professionals	1.0	(0.9-1.2)	0.739	0.7	(0.6-0.8)	<0.001	0.8	(0.7-1.0)	0.082	1.2	(1.0-1.3)	0.018
Manual workers	1.0	(0.9-1.1)	0.927	1.0	(0.9-1.1)	0.507	1.0	(0.9-1.1)	0.213	1.1	(1.0-1.2)	0.083
Others	1.0	(0.8-1.1)	0.403	1.3	(1.1-1.4)	<0.001	1.0	(0.9-1.2)	0.122	1.1	(0.9-1.2)	0.794
Hospital categorization												
Severe	0.9	(0.8-1.1)	0.933	1.1	(1.0-1.3)	0.173	1.5	(1.2-1.8)	0.002	0.8	(0.7-0.9)	<0.001
Moderate	0.9	(0.8-1.0)	0.120	1.1	(1.0-1.2)	0.220	1.4	(1.2-1.7)	0.002	1.1	(1.0-1.2)	<0.001
General	1	Ref		1	Ref		1	Ref				
ED triage severity rate	1.0	(1.0-1.0)	<0.001	1.0	(1.0-1.0)	<0.001	1.0	(1.0-1.0)	<0.001	1.0	(1.0-1.0)	<0.001

	Blood culture			Central venous catheter			Lactic acid			Antibiotics		
	OR	95% CI	<i>P-value</i>	OR	95% CI	<i>P-value</i>	OR	95% CI	<i>P-value</i>	OR	95% CI	<i>P-value</i>
Sex												
ED observation rate	1.0	(1.0-1.0)	0.040	1.0	(1.0-1.0)	0.001	1.0	(1.0-1.0)	<0.001	1.0	(1.0-1.0)	<0.001
Place of ED resources												
Sufficiency	1	Ref		1	Ref		1	Ref		1	Ref	
Not sufficiency	1.0	(0.9-1.1)	0.936	0.9	(0.9-1.0)	0.112	0.8	(0.7-0.9)	<0.001	0.9	(0.9-1.0)	0.045
Policy stage												
Pre-policy intervention	1	Ref		1	Ref		1	Ref		1	Ref	
Trial of categorization	1.0	(0.9-1.1)	0.217	1.0	(0.9-1.1)	<0.001	1.3	(1.2-1.5)	<0.001	0.9	(0.8-1.0)	0.660
Categorization policy	0.8	(0.7-1.0)	0.002	0.7	(0.7-0.8)	<0.001	1.2	(1.0-1.3)	0.471	0.8	(0.7-0.9)	<0.001

ED: emergent department; OR: odds ratio

Table 4 The rescue operation multivariate logistic regression analysis of major trauma patients

	<u>Rescue operation</u>			<u>Rescue operation</u>		
	OR ^a	95% CI	<i>P-value</i>	OR ^b	95% CI	<i>P-value</i>
Sex						
Female	1	Ref		1	Ref	
Male	1.1	(0.9-1.3)	0.295	1.1	(0.9-1.3)	0.385
Age						
≤ 39	1	Ref		1	Ref	
40-54	0.9	(0.7-1.0)	0.455	1.0	(0.8-1.2)	0.354
55-64	0.9	(0.7-1.1)	0.572	1.0	(0.8-1.3)	0.367
≥ 65	0.6	(0.5-0.7)	<0.001	0.7	(0.6-0.9)	0.001
Charlson Comorbidity Index						
≤ 1	0.7	(0.6-0.8)	<0.001	1	Ref	
≥ 2	1	Ref		0.8	(0.6-1.0)	0.019
Income						
Quantile 1(Lowest)	1	Ref		1	Ref	
Quantile 2	0.8	(0.6-1.0)	0.172	0.9	(0.7-1.2)	0.752
Quantile 3	0.8	(0.8-1.3)	0.301	0.8	(0.6-1.1)	0.179
Quantile 4	1.0	(0.6-1.0)	0.235	0.9	(0.7-1.2)	0.909
Quantile 5(Highest)	0.9	(0.7-1.2)	0.781	0.9	(0.7-1.2)	0.927
Occupation						
Dependents of the insured individuals	1	Ref		1	Ref	
Civil servants, teachers, military personnel, and veterans	0.9	(0.7-1.3)	0.890	1.1	(0.7-1.5)	0.317
Nonmanual workers and professionals	0.9	(0.7-1.2)	0.785	0.8	(0.6-1.0)	0.105
Manual workers	0.8	(0.6-0.9)	0.003	0.8	(0.6-1.0)	0.056
Others	1.2	(0.8-1.3)	0.148	1.0	(0.8-1.4)	0.231
Hospital categorization						
Severe	1.9	(1.5-2.4)	<0.001	1.3	(1.0-1.8)	0.071
Moderate	1.2	(0.9-1.5)	0.034	1.1	(0.9-1.4)	0.491
General	1	Ref		1	Ref	.
ED triage severity rate	1.01	(1.002-1.016)	0.016	1.0	(1.0-1.0)	0.058
ED observation rate	1.03	(1.002-1.038)	<0.001	1.0	(1.0-1.0)	0.125
Place of ED resources						
Sufficiency	1	Ref		1	Ref	
Not sufficiency	1.0	(0.8-1.2)	0.910	1.1	(0.9-1.4)	0.250
Policy stage						
Pre-intervention	1	Ref		1	Ref	
Trial of categorization	0.9	(0.8-1.2)	0.467	1.0	(0.8-1.2)	0.345
Categorization policy	0.9	(0.7-1.1)	0.105	0.8	(0.6-0.9)	0.017

^a OR: single effect; ^b OR: multivariate generalized linear model; ED: emergent department

Table 5 The process and outcome quality summary for four critical time-sensitive diseases after categorization of hospital emergency capability implementation

	Acute ischemic stroke ^a	ST-segment elevation MI ^b	Septic shock ^c	Major trauma ^d
Process: major diagnosis indicator	■	↑	↓↓	NA
Process: major treatment indicator	↑↑	↑↑	↓↓	↓↓
Upper transfer rate	↑↑	↓	↑	↑↑
Diagnosis cost	↑↑	↑↑	↑	↑↑
Outcome: 1-day mortality rate	↓	↑	↑	↑
Outcome: 7-day mortality rate	↑	■	↑	↑
Outcome: 30-day mortality rate	↑	↑	↑↑	↑
Total cost	↑↑	↑	■	■

Note: ↓↓ significant decrease, ↓ decrease but not significant, ■ no apparent change, ↑ increase but not significant, ↑↑ significant increase, NA not applicable

Note: red color represent got worst; green color represent got improve

^a Acute ischemic stroke major diagnosis: head image; major treatment: IV-tPA thrombolysis, subordinate treatment antiplatelet drugs

^b ST-elevation MI major diagnosis: EKG; major treatment: PCI, subordinate treatment antiplatelet drugs

^c Septic shock major diagnosis: culture; major treatment: antipathogen, subordinate treatment: central venous catheter

^d Major trauma major diagnosis: NA; major treatment: rescue operation, subordinate treatment: NA

CVC: central venous catheter; EKG: Electrocardiography; IV-tPA: intravenous tissue plasminogen activator; MI: myocardial infarction; NA: not applicable; PCI: Percutaneous coronary intervention

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Table1Thediagnosisandtreatmentmultivariate logistic regression analysis of acute ischemic stroke patients.doc](#)
- [BMCSupplementTablesFigure.doc](#)