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ORIGINAL RESEARCH

Factors Associated With Medical Staff's Engagement and Perception of a Quality Improvement Program for Acute Coronary Syndromes in Hospitals: A Nationally Representative Mixed-Methods Study in China

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BACKGROUND: Medical staff represent critical stakeholders in the process of implementing a quality improvement (QI) program. Few studies, however, have examined factors that influence medical staff engagement and perception regarding QI programs.

METHODS AND RESULTS: We conducted a nationally representative survey of a QI program in 6 cities in China. Quantitative data were analyzed using multilevel mixed-effects linear regression models, and qualitative data were analyzed using the framework method. The engagement of medical staff was significantly related to knowledge scores regarding the specific content of chest pain center accreditation (β=0.42; 95% CI, 0.27–0.57). Higher scores for inner motivation (odds ratio [OR], 1.79; 95% CI, 1.18–2.72) and resource support (OR, 1.52; 95% CI, 1.02–2.24) and lower scores for implementation barriers (OR, 0.81; 95% CI, 0.67–0.98) were associated with improved treatment behaviors among medical staff. Resource support (OR, 4.52; 95% CI, 2.99–6.84) and lower complexity (OR, 0.81; 95% CI, 0.65–1.00) had positive effects on medical staff satisfaction, and respondents with improved treatment behaviors were more satisfied with the QI program. Similar findings were found for factors that influenced medical staff's assessment of QI program sustainability. The qualitative analysis further confirmed and supplemented the findings of quantitative analysis.

CONCLUSIONS: Clarifying and addressing factors associated with medical staff's engagement and perception of QI programs will allow further improvements in quality of care for patients with acute coronary syndrome. These findings may also be applicable to other QI programs in China and other low- and middle-income countries.

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Key Words: acute coronary syndromes ■ medical staff ■ mixed-methods study ■ quality improvement

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CLINICAL PERSPECTIVE

What Is New?

- Understanding the content of a quality improvement (QI) program and internal motivation are main factors that influence medical staff engagement and improvements in treatment behaviors.
- Resources that support and simplify QI program standards are critical for satisfaction and sustainability of the program.

What Are the Clinical Implications?

- The engagement and perception of frontline medical professionals regarding QI initiatives are prerequisites for successful implementation of QI interventions.
- Factors influencing medical staff engagement and perception regarding QI programs are a relatively underdeveloped area of study.
- Clarifying and addressing those factors associated with medical staff's engagement in and perception of a QI program will allow further improvements in quality of care for patients with acute coronary syndrome.

Nonstandard Abbreviations and Acronyms

CPC	chest pain center
NCPCP	National Chest Pain Centers Program
QI	quality improvement

Many countries have implemented thorough quality improvement (QI) interventions to improve quality of care in acute coronary syndrome (ACS).[1] Because time is critical for patients with ACS, early diagnosis and standardized treatment are critical to enhancing ACS care quality. Comprehensive QI interventions focusing on the development and accreditation of chest pain centers (CPCs) can shorten the time for patients to seek care, increase the rate of standardized treatment, and improve the quality of ACS care.[2–5] However, previous research has found that quality of health care services frequently falls short of basic clinical standards or QI program performance targets, with most interventions improving process quality indicators, such as drug use, but not outcome quality, especially in-hospital mortality and major adverse cardiovascular events.[6–9] Broad consultation with stakeholders, particularly frontline medical staff, is crucial to understanding the gaps between "what we know" and "what we do," especially in a complex QI program.[10,11] The engagement and perception of frontline medical professionals with respect to QI programs are prerequisites for successful implementation of QI interventions.[12–14] Increasing employee involvement and communication, as well as improving staff satisfaction, is an important facilitator of continuous quality improvement.[15,16]

Factors influencing medical staff engagement and perception regarding QI programs are a relatively underdeveloped area of research,[17,18] with most studies using qualitative analysis.[19–21] However, evaluating the process from the perspective of frontline medical staff is crucial for identifying potential obstacles and impediments to implementing a QI program. To our knowledge, few studies have explored factors associated with engagement and satisfaction among medical staff, their changes in medical treatment behavior, and their attitudes toward the sustainability of a QI program, especially in China's health care system. According to the motivation theory, inherent motivation of medical staff to provide quality care for patients pushes them to implement changes.[16,22] Furthermore, the social cognitive theory emphasizes importance of resources and situational support for changes in behavior.[23] Studies have pointed out that enthusiasm for a QI program may be high at beginning,[24] and there is an urgent need to explore how medical staff satisfaction and motivation can be maintained under the pressure of a busy daily schedule.

The Chinese Cardiovascular Association launched the National Chest Pain Centers Program (NCPCP) in January 2016, which is the first nationwide, hospital-based, comprehensive, continuous QI program, with the ultimate goal to improve early diagnosis and treatment of ACS and improve clinical outcomes of patients in China. Accreditation of CPCs is the core of the program. The detailed design and interventions of the NCPCP have been published previously.[25] In brief, all the tertiary and secondary hospitals that joined the NCPCP need to register the program staggered. Registered hospitals should prepare for the accreditation process according to the unified China Chest Pain Center Accreditation Criteria. The CPCs accreditation is implemented by the Chinese Cardiovascular Association, which is under the direction of the National Health Commission. With implementation of the NCPCP, key questions remain unanswered, such as which factors influence medical staff engagement and how frontline staff perceive the QI program. The present study followed a logical path from participation to behavioral changes to overall QI program satisfaction and sustainability. We conducted a mixed-methods study using quantitative and qualitative analysis in parallel with implementation of the QI program, which is recommended for evaluating complex programs.[26] We aimed to (1) explore those factors associated with medical staff engagement in the QI program and factors that influence behavioral changes in medical treatment

after implementing the QI program, and (2) investigate those factors that influence medical staff satisfaction and attitudes toward program sustainability.

METHODS

Data to reproduce the results presented here can be made available upon reasonable request.

Study Design

In this study, we used a multistage cluster sampling method. Up to May 2021, 1927 hospitals in 31 provinces had a certified CPC in China, and >5000 hospitals had joined the QI program. The distribution of CPCs varies considerably across regions, with more CPCs in eastern China (Figure S1). First, 6 cities were randomly chosen by staff at the national headquarters of the CPCs to represent cities nationally, according to geographic region and the degree of development of CPCs. These 6 cities included Suzhou, Wuhan, Changsha, Hefei, Chongqing, and Shenzhen. Characteristics of the selected cities are shown in Table S1. Second, according to the sample size formula based on the percentage of medical staff from cardiology and departments aware of the QI program, 20 hospitals whose CPCs had been previously accredited were randomly selected in each city. All hospitals with a CPC in Hefei and Changsha were chosen because the total number was <20. Finally, 10 medical staff involved in the accreditation and development process of the CPCs from departments of cardiology and emergency medicine were chosen at random in each hospital to participate in the survey. The director and coordinator of each CPC were invited to participate in semistructured key informant interviews to further investigate changes in their medical practice, treatment behaviors, satisfaction, and opinions regarding sustainability of the program (Figure 1). The Ethics Committee of Peking University Health Science Center approved the entire study (IRB00001052-21020). Written informed consent was obtained from participants before they completed the questionnaires or participated in the interviews.

Data Collection

The questionnaire design was based on the motivation theory and the social cognitive theory. The questions were designed according to the specific content of each domain. The motivation theory focuses on whether organizational members collectively value a change to be implemented.[27] The social cognitive theory identifies 3 implementation determinants: task demands, resource availability, and situational factors.[23] The initial questionnaire focused on participants' basic information as well as their involvement in and perception of the QI program. A pilot test was conducted in Peking University First Hospital and Suzhou Kowloon Hospital, both of which have accredited CPCs to ensure content validity of the questionnaire. We implemented the pilot to know whether the questions were understandable and whether the questions fully reflected the content and aims of the survey through interviews with participants in the pilot study. The final version of the questionnaire was developed following 2 rounds of expert discussions and the pilot test results. A paper version of the questionnaires was completed by uniformly trained survey administrators in face-to-face sessions with medical staff. The surveys were then checked by verifiers after completion. After the questionnaires were collected, a database was constructed using EpiData3.1, and 2 research assistants double-entered and cross-checked the entered data to ensure data quality. Among the 927 questionnaires, 11 responses from staff who had not participated in the CPC accreditation program were removed, and 916 respondents were included in our final analysis.

The interviews were semistructured, with most consisting of an in-depth individual interview and the remainder consisting of a focus group discussion. All interviews were conducted by trained qualitative researchers (Y.J., S.Z., J.M., X.D., and N.L., of whom 3 were women) and were recorded by note-takers. The content of the face-to-face interviews differed; interviews with the director of each CPC focused on the organizational context of the program, implementation process, and perception of the QI program, and those with the coordinator emphasized engagement and behavior changes. The average length of each interview was ≈50 minutes. The survey was conducted in 90 hospitals with CPCs between July and August 2021 (Table S2). A total of 927 medical staff completed the questionnaire, and key informant interviews were conducted with 87 directors and 78 coordinators of CPCs (Table S3). The effectiveness rate of the questionnaire was 97%, and the response rate of the key informant interviews was 91.67%.

Study Variables

The primary outcome variables in our study were medical staff's engagement, satisfaction with the QI program, changes in medical treatment behavior, and their opinion regarding sustainability of the QI program. Engagement was measured according to activity participation using a composite indicator by averaging the scores of 5 questions. Each question had a score ranging from 0 to 4, resulting in an engagement score ranging from 0 to 4 with higher standing for more engagement. The changes in medical treatment behavior, satisfaction with the QI program, and perception of program sustainability were measured using a 5-level response scale. We used a code of 1 for the response

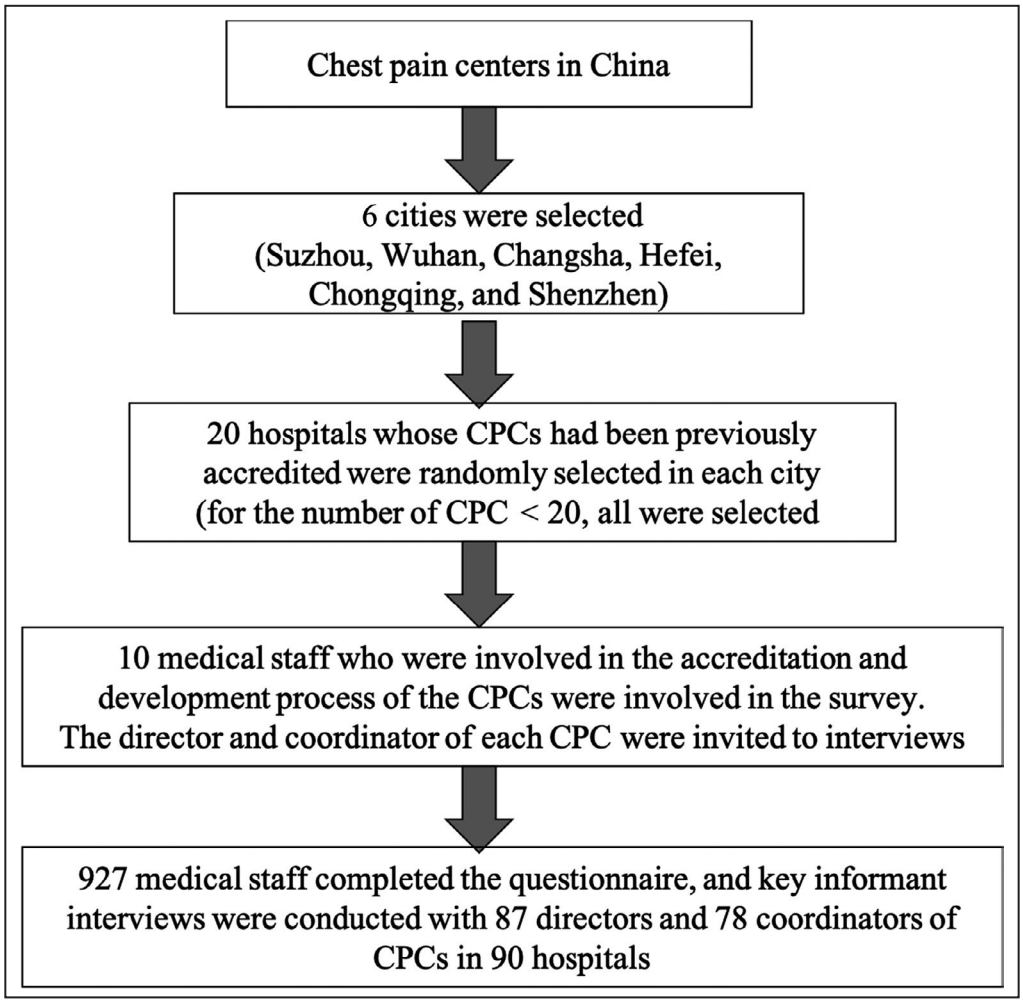

Figure 1. Steps of multistage cluster sampling used in this study.
CPCs indicates chest pain centers.

"Significantly or slightly improved," Very satisfactory or satisfactory," and "Very sustainable or sustainable," and 0 for other responses, respectively (Table 1).

The independent variables primarily comprised 4 aspects, each of which was constructed using different questions with a 7-level response ranging from 0 (never/strongly disagree) to 6 (always/strongly agree). First, medical staff's initial interest in the QI program was dubbed their inner motivation to participate in the QI program. Second, 4 questions were used to generate information regarding the resources required to implement the QI program successfully. Third, 4 questions addressed the barriers to QI program implementation. Fourth, the QI program content knowledge was queried using 4 questions (Table 1). Additionally, a 5-level response scale was used to assess 2 independent variables: complexity of the QI program and familiarity with reperfusion therapy.

Information on participants' sociodemographic status, specialities, years of work experience, and the types of CPC accreditation (basic or comprehensive) were used to control potential confounding. These variables included age, sex (male or female), education attainment (doctoral degree, master's degree, bachelor's degree, and other), marital status (married, unmarried, and other), position title (chief, attending, and junior), years working in the hospital, administrator (yes or no), and accreditation type (basic versus comprehensive).

Statistical Analysis

Descriptive statistical analyses were used to describe the demographic characteristics of the study sample. The Pearson chi-square and Student *t* tests were used to compare categorical and continuous variables, summarized as percentages or medians, respectively. We used a multilevel mixed-effects linear regression model to examine factors associated with medical staff engagement and evaluation of the QI program, adjusting for clustering at hospital level and allowing for hospital-level estimates as random effects.[28,29] The goodness of fit for statistical models was evaluated using likelihood ratio tests. Engagement was measured

Table 1. Main Dependent and Independent Variables in Our Study

	Variables	Questions	Scales and meaning
Dependent variables	Engagement	1. Number of times spent training primary health care centers in 2020. 2. Number of times spent training community members in 2020. 3. Number of times spent attending joint meetings in 2020. 4. Number of times spent attending quality analysis and feedback meetings in 2020. 5. Number of times spent attending typical case seminars in 2020.	0–4, average of the 5 questions, 0: 0 times; 4: ≥4 times
	Medical treatment behavior	1. How your ACS patient care behavior has changed since the QI program was implemented?	0–1, 1: significantly or slightly improved, 0: others
	Satisfaction	1. Are you satisfied with the QI program?	0–1, 1:very satisfactory or satisfactory, 0: others
	Sustainability	1. What do you think of the sustainability of the QI program?	0–1, 1: very sustainable or sustainable, 0: others
Independent variables	Motivation	1. I am willing to participate in work related to chest pain center accreditation.	0–6, average of the 5 questions, 0: never/strongly disagree 6: always/strongly agree
		2. I believe there is a need to improve the quality of ACS care through chest pain center accreditation.	
		3. Chest pain center accreditation improves outcomes for patients with ACS.	
		4. Chest pain center accreditation can benefit me.	
		5. Chest pain center accreditation can benefit hospitals.	
	Resources	1. We have the resources needed to support the implementation of chest pain center accreditation.	0–6, average of the 4 questions, 0: never/strongly disagree 6: always/strongly agree
		2. In the process of building the chest pain center, all departments can coordinate. 3. We get regular feedback from the headquarters of the chest pain centers on implementation of our chest pain center accreditation standards.	
		4. The headquarters of the chest pain centers supports for our chest pain center to promote further quality improvement.	
	Barriers	1. Based on current resources, chest pain center accreditation is not effectively implemented.	0–6, average of the 4 questions, 0: never/strongly disagree 6: always/strongly agree
		2. I participated in the work related to chest pain center accreditation because of pressure from the hospital.	
		3. I participated in the work related to chest pain center accreditation because of peer pressure.	
		4. Chest pain center accreditation has a negative impact on my daily work.	
	Knowing	1. I fully understand the specifics of chest pain center accreditation.	0–6, average of the 4 questions, 0: never/strongly disagree 6: always/strongly agree
		2. I know the strategies to ensure effective implementation of chest pain center accreditation.	
		3. I know that chest pain center accreditation has a positive impact on my daily work.	
		4. I am aware of results and impact of chest pain center accreditation.	
	Complexity	1. How complex are the chest pain center accreditation standards?	0–4, 0: very simple, 4: very complex
	Familiarity	1. How familiar are you with the risk stratification of NSTEMI/UA and the principles of reperfusion therapy? 2. How familiar are you with the risk stratification of STEMI and the principles of reperfusion therapy?	0–4, average of the 2 questions, 0: very unfamiliar 4: very familiar

ACS indicates acute coronary syndrome; NSTEMI, non–ST-segment–elevation myocardial infarction; QI, quality improvement; STEMI, ST-segment–elevation myocardial infarction; and UA, unstable angina.

as a continuous variable, whereas behavior changes, satisfaction, and sustainability of the QI program were measured as dichotomous variables. Stata version 14.1 for Mac (StataCorp, College Station, TX) and R Studio Version 1.2.5042 (R Project for Statistical Computing, Vienna, Austria) were used for the statistical analyses.

The Consolidated Criteria for Reporting Qualitative Studies checklist was completed for qualitative analysis by a research team, study design, and analysis and findings. The research team were from the Department of Global Health, Peking University School of Public Health. Before the interview, each interviewer received

extensive training. A video recording was made with the consent of the interviewee, and the text was transcribed verbatim. NVivo 11.0 (QSR International, Melbourne, Australia) was used for theme coding.[30] The interview transcripts were coded by a well-trained author (S.D.Z.) using the main dependent variables as the primary codes. The independent variables in our study were coded as secondary codes under each primary code, and the corresponding textual information was categorized into secondary codes on the basis of the content of the interviews. A second coder (Y.J.) independently coded 10% of the transcripts to ensure interrater agreement. Codes were improved through pilot tests and discussion, resulting in 4 final descriptive categories.

RESULTS

Respondents' Characteristics

The demographic characteristics of the respondents in our study are shown in Table 2. Overall, respondents' average age was 35.7 years, with a mean of 10.1 years of work experience in their hospital. The respondents were predominantly women (62.6%), were married (82.4%), did not hold a management position (84%), and most (93.3%) had a bachelor's degree or higher. Some demographic characteristics were significantly different between doctors and nurses; doctors were older (36.7 versus 34.3), comprised a higher percentage of men (60.5% versus 3.3%), had higher education levels, and were more likely to have a midlevel or senior title than nurses (Table 2).

Medical Staff Engagement and Behavior Changes

The factors associated with medical staff engagement in the QI program are shown in Figure 2. After controlling for covariates, having better knowledge about the specific contents of CPC accreditation had a significantly positive effect on QI engagement (β=0.42; 95% CI, 0.27–0.57), whereas the complexity of the accreditation process had a slightly negative impact on medical staff engagement (β=−0.07; 95% CI, −0.15 to 0.01). Figure 3 depicts those factors that influenced medical staff behavioral changes in medical treatment. Higher scores for inner motivation (odds ratio [OR], 1.79; 95% CI, 1.18–2.72) and for resource support (OR, 1.52; 95% CI, 1.02–2.24), and lower scores for implementation barriers (OR, 0.81; 95% CI, 0.67–0.98) were associated with improved

Table 2. Demographic Characteristics of the Study Population

	Total (n=916)	Doctor (n=547)	Nurse (n=369)	*P* value
Age, y, mean (SD)	35.7 (7.11)	36.7 (6.91)	34.3 (7.16)	<0.001
Sex, n (%)				
Male	343 (37.4)	331 (60.5)	12 (3.3)	<0.001
Female	573 (62.6)	216 (39.5)	357 (96.7)	
Marital status, n (%)				
Unmarried	151 (16.5)	82 (15.0)	69 (18.7)	0.332
Married	755 (82.4)	459 (83.9)	296 (80.2)	
Other	10 (1.1)	6 (1.1)	4 (1.1)	
Title, n (%)				
Chief	228 (24.9)	190 (34.7)	38 (10.3)	<0.001
Attending	458 (50.0)	269 (49.2)	189 (51.2)	
Junior	230 (25.1)	88 (16.1)	142 (38.5)	
Education, n (%)				
Doctoral degree	62 (6.8)	61 (11.2)	1 (0.3)	<0.001
Master's degree	284 (31.0)	278 (50.8)	6 (1.6)	
Bachelor's degree	509 (55.6)	202 (36.9)	307 (83.2)	
Other*	61 (6.7)	6 (1.1)	55 (14.9)	
Working, mean (SD)	10.1 (7.00)	9.09 (6.65)	11.7 (7.22)	<0.001
Administrator, n (%)				
No	769 (84.0)	469 (85.7)	300 (81.3)	0.088
Yes	147 (16.0)	78 (14.3)	69 (18.7)	
Accreditation type, n (%)				
Basic	377 (41.2)	222 (40.6)	155 (42.0)	0.719
Comprehensive	539 (58.8)	325 (59.4)	214 (58.0)	

*Other indicates level of education at junior college and below.

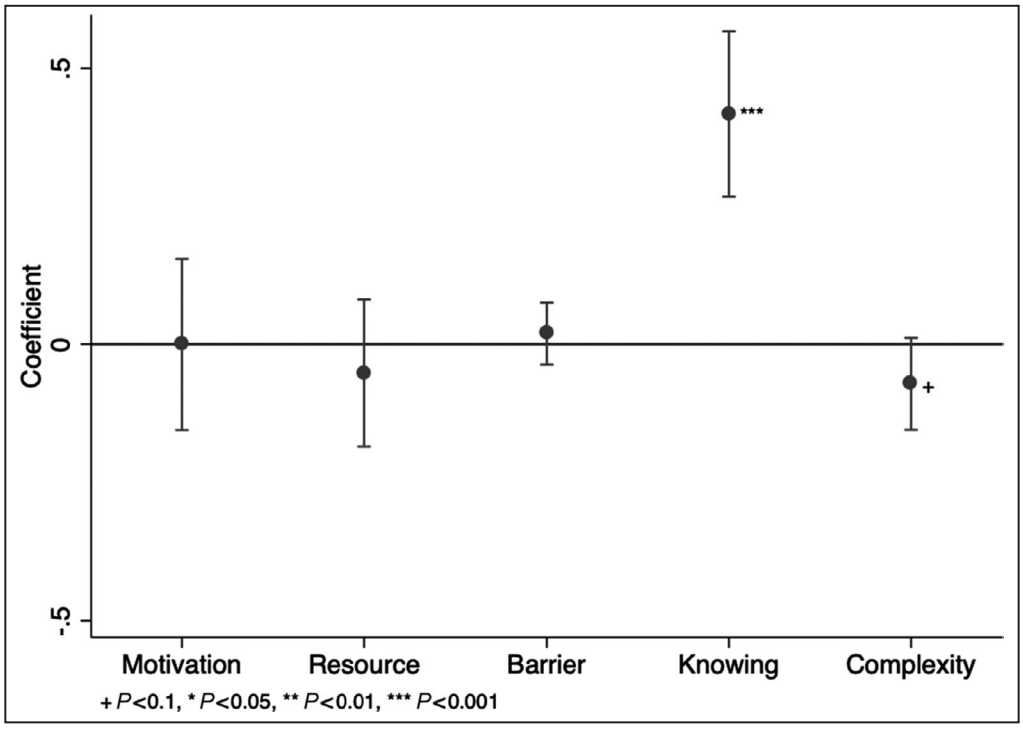

Figure 2. Factors associated with medical staff's engagement with the quality improvement program.

medical treatment behaviors among respondents. Similarly, respondents with higher scores for familiarity with reperfusion therapy and QI participation were more likely to modify their medical treatment behaviors in the QI program (OR, 1.51; 95% CI, 1.02–2.22; OR, 1.27; 95% CI, 1.01–1.59, respectively).

Satisfaction and Sustainability of QI Program From the Perspective of Medical Staff

In the unadjusted model, similar to factors associated with medical staff's perception regarding sustainability of the QI program, higher scores for inner motivation (OR, 1.55; 95% CI, 1.01–2.40) and resource support (OR, 5.04; 95% CI, 1.01–2.40) and lower scores for implementation complexity (OR, 0.81; 95% CI, 0.68–0.98) were significantly linked with medical staff's satisfaction with the QI program (Tables 3 and 4). In the adjusted model, resource support (OR, 4.52; 95% CI, 2.99–6.84) and knowledge of the QI content (OR, 1.47; 95% CI, 1.01–2.06) had positive effects on medical staff satisfaction, and QI sustainability was slightly associated with inner motivation (OR, 1.40; 95% CI, 0.95–2.06) and resource support (OR, 2.82; 95% CI, 2.02–3.93). When we added the scores for participation and familiarity with reperfusion therapy as well as changes in respondents' behaviors to the model, participants with improved medical treatment behaviors (OR, 3.48; 95% CI, 1.90–6.37) and a higher familiarity score (OR, 1.36; 95% CI, 0.98–1.87) were slightly more satisfied with the QI program. Furthermore, the complexity of the QI program was negatively related to the satisfaction of medical staff. Similar findings were found for factors that influenced medical staff's assessment of QI sustainability (Table 4).

Findings From Key Informant Interviews

On the basis of thematic analysis of key informant interviews, 4 key themes emerged, including medical staff engagement, behavioral changes in medical treatment, satisfaction, and perception of sustainability of the QI program. These themes were analyzed to help explain and supplement the quantitative findings.

Engagement

Similar to the findings of the quantitative study, the main factors influencing the engagement of medical staff in the QI program included knowledge of the program's content and impact. Establishment of the CPC increased visibility of the cardiology department and increased patient volume, which in turn increased the income of medical staff. More importantly, patients were treated promptly, such that complications like heart failure and shock were significantly reduced,

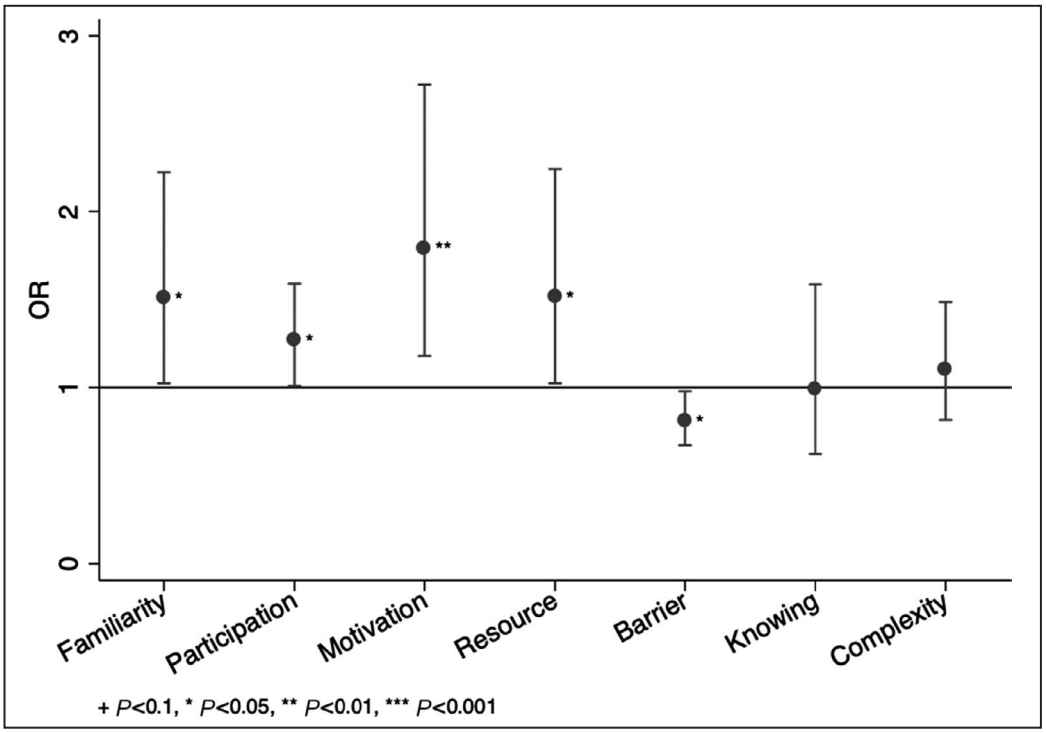

Figure 3. Factors associated with behavioral changes in medical treatment among medical staff.
OR indicates odds ratio.

and patients healed well, from which doctors gained professional satisfaction. At the same time, the complexity of the accreditation program somewhat discouraged the participation of medical staff.

> *The treatment effect for ACS is very good; this will increase publicity for the department, bringing in more patients, increasing the benefits to our entire department, and increasing the income of each health care staff member. (Cardiologist, CPC coordinator)*

> *As the number of cases treated grows, doctors' ability to treat grows stronger, and they will have a sense of accomplishment. They will be more inclined to participate in the chest pain center accreditation program, which is critical. (Cardiology chief, CPC director)*

> *The development of a chest pain center necessitates a large amount of content and is also very complicated, and doctors may be uninterested and indifferent toward participation. (Cardiology chief, CPC director)*

Medical Treatment Behavior Changes

Nearly all medical staff surveyed believed that the CPC accreditation program made their treatment behavior more standardized and efficient. The reasons for the changes were as follows: First was inner motivation regarding the program, which could effectively reduce patient complications and mortality by optimizing the treatment process and promptly treating patients using risk stratification. Second, continuous learning made medical staff more familiar with the reperfusion process in patients with ACS, and these evidence-based standards provided everyone with a foundation for decision making. Third, policy and resource support were critical. With administrative support, each department could adhere to clinical guidelines and standardized procedures and collaborate to standardize the treatment.

> *We work in a more standardized manner because there is a standardized treatment process, including drug dosage, which is evidence based. We must seize this opportunity, and the earlier, the better. Based on the risk stratification of patients with ST-elevation myocardial infarction, we also tend to be more aggressive in treatment, which may reduce patient mortality and complications. (Cardiologist, CPC coordinator)*

Table 3. Factors Associated With Satisfaction of Medical Staff on the Quality Improvement Program

Variables	Model 1	Model 2	Model 3
Motivation	1.55 (1.01–2.40)*	1.31 (0.82–2.07)	1.09 (0.67–1.77)
Resource	5.04 (3.41–7.46)†	4.52 (2.99–6.84)†	4.22 (2.74–6.50)†
Barrier	1.01 (0.89–1.14)	0.99 (0.87–1.13)	0.99 (0.86–1.14)
Knowing	1.14 (0.81–1.60)	1.47 (1.01–2.16)*	1.48 (0.97–2.26)‡
Complexity	0.81 (0.68–0.98)*	0.87 (0.71–1.07)	0.81 (0.65–1.00)*
Behavioral changes			3.48 (1.90–6.37)†
Engagement			1.09 (0.92–1.29)
Familiarity			1.36 (0.98–1.87)‡
Education (doctoral)			
Master's degree		1.95 (0.96–3.99)‡	2.31 (1.09–4.89)*
Bachelor's degree		3.22 (1.48–7.00)†	3.69 (1.63–8.34)†
Other		4.02 (1.38–11.75)*	5.10 (1.61–16.19)†
Occupation (physician)		1.10 (0.66–1.83)	1.38 (0.79–2.41)
Age, y		0.99 (0.95–1.04)	1.00 (0.95–1.05)
Sex (male)		1.02 (0.69–1.53)	1.03 (0.67–1.57)
Marital status (unmarried)			
Married		1.21 (0.75–1.98)	1.24 (0.74–2.08)
Other		1.05 (0.23–4.74)	1.14 (0.24–5.43)
Title (chief)			
Attending		1.85 (1.11–3.08)*	1.85 (1.09–3.14)*
Junior		2.08 (1.00–4.36)‡	2.44 (1.12–5.32)*
Working		1.01 (0.97–1.05)	1.00 (0.95–1.04)
Administrator (no)		0.84 (0.51–1.40)	0.75 (0.44–1.27)
Accreditation type (basic)		1.26 (0.86–1.85)	1.19 (0.79–1.79)

* $P<0.05$.
† $P<0.01$.
‡ $P<0.1$.

Suppose a hospital wants to build a chest pain center. In that case, it will almost certainly require the direct participation of the hospital director or even the president because multiple departments are involved, and it is extremely difficult to coordinate each department to standardize treatment during the process. (Cardiology chief, CPC director)

Satisfaction

Respondents believed that the accreditation of CPCs was beneficial to patients and the development of hospitals, as well as to the improvement of quality and skills among medical staff, but that the work involved, such as the requirements regarding paperwork and training in the accreditation standards, increased the burden on clinicians. Participants stated that, in particular, data recording in the CPC was extremely complicated, with hundreds of variables to fill in and numerous time node requirements, and that further optimization was urgently required to reduce the workload of medical staff. Most interviewees stated that accreditation of the CPC had 2 other aspects that did not meet their expectations. First, participants felt that there were problems with coordination among various departments, particularly among the prehospital 120 system, the emergency department, and the cardiology department. Second, interviewees stated that there was a problem with patient awareness in that many patients do not seek medical treatment promptly after experiencing chest pain symptoms and do not choose to call 120 in the first place.

The construction of the chest pain center is very good in terms of development of the hospital, the patients, and society. But I am personally very hesitant to take on the burden of the chest pain center because I believe it is too exhausting. (Cardiologist, CPC coordinator)

I believe the chest pain center is still falling short of my expectations, and I believe we are struggling with prehospital docking.

Table 4. Factors Associated With Opinions of Medical Staff on Sustainability of the Quality Improvement Program

Variables	Model 1	Model 2	Model 3
Motivation	1.66 (1.15–2.41)*	1.40 (0.95–2.06)†	1.20 (0.80–1.81)
Resource	3.09 (2.24–4.25)*	2.82 (2.02–3.93)*	2.57 (1.83–3.61)*
Barrier	0.97 (0.86–1.10)	0.95 (0.83–1.08)	0.96 (0.83–1.10)
Knowing	0.92 (0.67–1.28)	1.17 (0.83–1.67)	1.17 (0.79–1.72)
Complexity	0.81 (0.67–0.98)‡	0.87 (0.72–1.07)	0.81 (0.65–1.00)†
Behavioral changes			3.75 (2.24–6.28)*
Engagement			1.01 (0.86–1.20)
Familiarity			1.37 (1.00–1.87)†
Education (doctoral)			
Master		0.95 (0.50–1.79)	0.98 (0.51–1.89)
Bachelor		1.77 (0.88–3.55)	1.75 (0.84–3.65)
Other		1.03 (0.38–2.79)	1.12 (0.38–3.25)
Occupation (physician)		1.27 (0.77–2.10)	1.50 (0.87–2.59)
Age		1.01 (0.96–1.05)	1.01 (0.97–1.06)
Sex (male)		1.19 (0.81–1.75)	1.27 (0.85–1.90)
Marriage (unmarried)			
Married		1.18 (0.73–1.91)	1.19 (0.72–1.98)
Other		1.61 (0.35–7.46)	1.64 (0.33–8.10)
Title (chief)			
Attending		1.37 (0.84–2.23)	1.35 (0.81–2.23)
Junior		1.98 (0.96–4.06)†	2.34 (1.09–5.01)‡
Working		0.99 (0.95–1.03)	0.97 (0.93–1.01)
Administrator (No)		1.06 (0.65–1.73)	1.03 (0.62–1.71)
Accreditation type (basic)		1.00 (0.70–1.42)	0.93 (0.64–1.36)

* $P<0.01$.
† $P<0.1$.
‡ $P<0.05$.

These enhancements may necessitate the support of the health administration. (Cardiology chief, CPC director)

Patients experiencing chest pain should be instructed to call 120 as soon as possible. We are doing this work to make patients realize that this is a problem in the first place and improve their awareness, which is still lacking. This will necessitate the efforts of the entire community, government, and society. (Cardiology chief, CPC director)

Sustainability

Resource support is a critical factor in effectively maintaining the sustainability of CPC accreditation. This includes the support of the health administration department, which considers accreditation of a CPC as one of the indicators of hospital assessment at all levels and provides specific supporting resources. Support at the hospital level is equally important, and hospital leaders should not view accreditation as the end goal but rather as the beginning because sustainable development of the CPC requires the continuous attention of hospital leaders. However, we found that the resource support was varied among different regions. From the quantitative and qualitative analysis, we saw that the western part of China, with fewer health care resources and economic growth, received less support and had lower motivation for medical staff (Table S4). Furthermore, the attitude of the CPC director is critical, and quality control in the CPC must be normalized, with interventions integrated into the routine work of medical staff, the department, and the hospital. Finally, the CPC's evaluation criteria must be further simplified; otherwise, it will be challenging to maintain the motivation of medical staff in the face of complex demands, and the effect of accreditation will be short-lived.

The construction of a chest pain center is a lengthy process. However, hospital leaders may believe that the process is

complete once the center has received certification. However, this is only the first step in the long process of chest pain center construction. (Cardiology chief, CPC director)

We just discussed how to make this project sustainable. I believe that some processes, such as data recording and the chest pain center's 3-meeting system, must be simplified. (Cardiologist, CPC coordinator)

The attention of some Municipal Health Commissions given to CPCs is insufficient, and they merely stay in the stage of document issuing. The Health Commission lacks the sense of urgency required to implement CPC accreditation. (Cardiology chief, CPC director)

DISCUSSION

There are many cases in which the results of a QI program do not meet expectations or the results differ considerably across regions and hospitals when QI programs are implemented,[31,32] and one of the key factors is attitude and engagement of stakeholders in the program.[17] We investigated factors influencing frontline medical staff engagement in the NCPCP using a combination of qualitative and quantitative methods. To the best of our knowledge, this was the first nationally representative study using a mixed-method design examining how to promote the role of medical staff, the most important stakeholders in a QI program, in ensuring the program's effective implementation and achieving the desired results. Our findings highlighted the importance of understanding the QI program's content as well as internal motivation for medical staff engagement and behavior changes in medical treatment. Furthermore, resources that support and simplify QI standards are critical for the satisfaction and sustainability of QI programs.

Employee engagement is defined as a positive, fulfilling, work-related state of mind characterized by vigor, dedication, and absorption.[33] Recognizing the content of the QI program, knowledge of the effects of the QI program, and anticipating the benefits are all necessary for medical staff to be engaged in a QI program.[34] It is crucial to strengthen training related to the QI program for medical staff, especially for departments with high staff mobility, such as emergency departments, and establish a training system with assessment as the mechanism. The complexity of interventions may conflict with existing priorities or daily work responsibilities among medical staff, which hampers their further engagement with the QI program.[35]

In terms of behavior changes, this is a critical link in the black box from intervention to patient outcome in terms of medical staff behavioral changes.[36] Interest in the QI program by medical staff serves as motivation for behavior changes,[20] which is reinforced by the support of internal and external resources.[37] Studying treatment guidelines on an ongoing basis, and participation in various training activities, are critical for the standardization and effectiveness of medical treatment. Hospitals should establish a reasonable incentive mechanism to promote the participation of medical staff and the optimization of treatment behavior.

Consistent with previous studies, our findings confirmed the importance of resource support from both government and organization leaders for the effectiveness and sustainability of a QI program.[31,38] The successful implementation of the NCPCP cannot rely solely on cardiology departments; close cooperation is required among the prehospital emergency system, emergency department, cardiology department, radiology department, and other related departments, as well as among network hospitals.[39] When it comes to the development of a CPC, government and hospital officials must provide substantial support in terms of human resources, necessary hardware and software, and financial support. The attention of leadership will strengthen the motivation of frontline medical staff to make behavioral changes and improve participation and implementation of QI program standards.[40] Positive interaction between leadership and medical staff is a key factor in ensuring the successful implementation and sustainable effectiveness of the QI program.

The effect of these programs might be hindered by a variety of factors; therefore, systems thinking is needed in the implementation process.[41] The improvement of emergency awareness and health literacy among patients with ACS requires joint efforts of the entire government, society, and community. NCPCP is a continuous QI program. The support from the government and hospitals cannot be limited to CPC accreditation but must be reflected in the daily operation and management of CPC. We found that the resource support from different regions varied substantially and was linked to regional economic development and health care resources. Closing the resources gaps in various areas is a critical challenge for the NCPCP's future implementation.

The complexity of intervention has been proven to be the main barrier to implementation of a QI program.[42,43] The enthusiasm of medical staff is difficult to maintain when the numerous needs of a program are too complex, especially when physicians are under a high level of clinical, research, and teaching pressure. According

to the normalization process theory, the effect of intervention can be sustained when the intervention becomes a regular and institutionalized component of the target group's everyday routine.[44] The key to improving medical staff satisfaction and program sustainability is to lessen the workload of medical staff during the development of CPCs. In particular, the requirements for data reporting for patients with acute chest pain must be further simplified. Reducing the workload of medical staff to fill in data through information technology is the critical direction that the QI program should focus on in the future.

Another finding indicated that after implementing the NCPCP program, respondents who had significant behavioral improvements and were more familiar with the reperfusion process for patients with ACS were more satisfied with the program and thought the effect was sustainable. Qualitative analysis further confirmed these results. Medical staff who had significant improvements in treatment behaviors and were more familiar with the reperfusion process for patients with ACS thought the NCPCP program improved their treatment and significantly improved patient outcomes, and these individuals derived professional satisfaction from the program. As a result, a crucial challenge in QI research will be how to motivate medical professionals to adopt improvement in behaviors.[45]

There are several strengths and limitations of our study. First, this was the first nationally representative study focusing on medical staff engagement and evaluation of a QI program for ACS. Second, the mixed-methods design allowed us to delve deeper into investigation of influencing factors to complement and validate the findings. As to limitations, the cross-sectional study design remained descriptive and interpretive, which limited our ability to determine a causal relationship. Furthermore, the questionnaires used in our study were developed by our research team and have not been tested in other environments, which may limit the generalizability of the results. However, we used several techniques to enhance the validity and reliability, including a pilot study and 2 rounds of expert discussions. We also followed strict quality control methods in data collection, collation, transcription, and analysis of the qualitative data to ensure the scientific validity of our results. In addition, cities in the northeastern and northwestern regions of China were not included in our study. Future studies can further explore the development of CPCs in the north of China and the comparison of CPCs between the south and the north.

CONCLUSIONS

Medical staff represent one of the essential stakeholders in the implementation of a QI program, and it is critical to determine which factors influence their engagement with and perception of the program. Clarifying and addressing factors associated with medical staff's engagement and perception of a QI program will allow for further improvement in the quality of care for patients with ACS. These findings may be applicable to other QI programs in China and other low- and middle-income countries.

ARTICLE INFORMATION

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Disclosures

None.

Supplemental Material

Tables S1–S4
Figure S1

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SUPPLEMENTAL MATERIAL

Table S1. Characteristics of the selected cities.

City	Population （10,000）	Land area (sq.km)	Per Capital GRP （Yuan)	Number of CPCs	ACS In-hospital mortality
Wuhan	906	8569	145545	26	1.64
Suzhou	723	8657	179174	30	1.95
Shenzhen	551	1997	203489	23	2.26
Chongqing	3416	82402	75828	26	1.27
Hefei	770	11445	115623	6	3.91
Changsha	738	11816	139877	10	1.29

Table S2. List of hospitals in our study.

ID	Hospital	Province	City/County	Accreditation type	Accreditation date
1	Anhui Provincial Hospital	Anhui	Hefei	Comprehensive	2017/4/20
2	The Second Hospital of Anhui Medical University	Anhui	Hefei	Comprehensive	2020/9/23
3	The First Hospital of Anhui Medical University	Anhui	Hefei	Comprehensive	2021/4/13
4	The Second People's Hospital of Hefei	Anhui	Hefei	Comprehensive	2019/10/31
5	The First People's Hospital of Hefei	Anhui	Hefei	Comprehensive	2018/11/2
6	Binhu Hospital of Hefei	Anhui	Hefei	Comprehensive	2021/4/13
7	The Eighth Affiliated Hospital,Sun Yat-Sen University	Guangdong	Shenzhen	Comprehensive	2014/12/12
8	Central Hospital of Shenzhen Longhua District	Guangdong	Shenzhen	Comprehensive	2017/9/2
9	People's Hospital of Shenzhen Yantian District	Guangdong	Shenzhen	Comprehensive	2019/4/11
10	Shenzhen Traditional Chinese Medicine Hospital	Guangdong	Shenzhen	Comprehensive	2021/5/17
11	The Third Hospital of Shenzhen Longgang District	Guangdong	Shenzhen	Basic	2019/12/12
12	Peking University Shenzhen Hospital	Guangdong	Shenzhen	Comprehensive	2019/4/11
13	Central Hospital of Shenzhen Baoan District	Guangdong	Shenzhen	Basic	2021/4/13
14	Union Shenzhen Hospital (Nanshan Hospital)	Guangdong	Shenzhen	Comprehensive	2017/12/14
15	University of Chinese Academy of Sciences Shenzhen Hospital	Guangdong	Shenzhen	Comprehensive	2021/4/13
16	Shenzhen Sun Yat-Sen Cardiovascular Hospital	Guangdong	Shenzhen	Comprehensive	2015/4/10
17	People's Hospital of Shenzhen	Guangdong	Shenzhen	Comprehensive	2015/7/23

18	Shiyan People's Hospital, Baoan District, Shenzhen	Guangdong	Shenzhen	Basic	2019/12/12
19	Shenzhen Shekou People's Hospital	Guangdong	Shenzhen	Basic	2018/8/6
20	People's Hospital of Shenzhen Longgang District	Guangdong	Shenzhen	Comprehensive	2016/11/4
21	People's Hospital of Shenzhen Luohu District	Guangdong	Shenzhen	Basic	2020/9/23
22	Central Hospital of Shenzhen Longgang District	Guangdong	Shenzhen	Comprehensive	2020/11/16
23	People's Hospital of Shenzhen Baoan District	Guangdong	Shenzhen	Comprehensive	2018/12/14
24	The University of Hong Kong-Shenzhen Hospital	Guangdong	Shenzhen	Comprehensive	2019/4/11
25	Traditional Chinese Medicine Hospital Baoan, Shenzhen	Guangdong	Shenzhen	Basic	2018/11/2
26	BenQ Medical Center	Jiangsu	Suzhou	Basic	2019/7/14
27	The First People's Hospital of Kubnshan	Jiangsu	Suzhou	Comprehensive	2016/7/24
28	The First People's Hospital of Taicang	Jiangsu	Suzhou	Comprehensive	2020/9/23
29	Taicang Hospital of Traditional Chinese Medicine	Jiangsu	Suzhou	Basic	2019/7/14
30	Traditional Chinese Medicine Hospital of Kunshan	Jiangsu	Suzhou	Comprehensive	2016/7/24
31	The People's Hospital of SND	Jiangsu	Suzhou	Basic	2018/11/2
32	Huqiao Hospital of Kunshan	Jiangsu	Suzhou	Basic	2017/11/3
33	Kunshan NO.3 People's Hospital	Jiangsu	Suzhou	Basic	2019/10/31
34	Suzhou industrial park, Xinghai hospital	Jiangsu	Suzhou	Basic	2017/12/14
35	Suzhou Municipal Hospital	Jiangsu	Suzhou	Comprehensive	2016/3/17
36	Qiandeng Hospital of Kunshan	Jiangsu	Suzhou	Basic	2018/12/14
37	Suzhou industrial park, Xinghu hospital	Jiangsu	Suzhou	Basic	2018/12/14

38	Suzhou Kowloon Hospital, Shanghai Jiaotong University Medical School	Jiangsu	Suzhou	Comprehensive	2014/12/12
39	Kunshan NO.4 People's Hospital	Jiangsu	Suzhou	Basic	2019/4/11
40	The Second People's Hospital of Kunshan	Jiangsu	Suzhou	Basic	2020/9/23
41	The Second Affiliated of Soochow University	Jiangsu	Suzhou	Comprehensive	2016/11/4
42	Kunshan NO.6 Hospital	Jiangsu	Suzhou	Basic	2018/12/14
43	Suzhou Hospital Of Traditional Chinese Medicine	Jiangsu	Suzhou	Basic	2021/4/13
44	The Central Hospital of Wuhan	Hubei	Wuhan	Comprehensive	2016/11/4
45	Wuhan Third Hospital-Tongren Hospital of Wuhan University	Hubei	Wuhan	Comprehensive	2017/7/22
46	Fifth Hospital in Wuhan	Hubei	Wuhan	Comprehensive	2017/4/20
47	CR & WISCO General Hospital	Hubei	Wuhan	Comprehensive	2017/4/6
48	Puai Hospital of Wuhan	Hubei	Wuhan	Comprehensive	2017/9/2
49	Wuhan NO.1 Hospital|Wuhan Hospital Of Chinese And Western Medicine	Hubei	Wuhan	Comprehensive	2017/9/2
50	Puren Hospital of Wuhan	Hubei	Wuhan	Comprehensive	2017/4/6
51	Red Cross Hospital of Wuhan	Hubei	Wuhan	Basic	2018/8/6
52	Union Hospital affiliated to Tongji Medical College of Huazhong University of Science and Technology	Hubei	Wuhan	Comprehensive	2016/11/4
53	Wuhan NO.6 Hospital	Hubei	Wuhan	Basic	2019/12/12
54	Wuhan Hankou Hospital	Hubei	Wuhan	Basic	2020/9/23

55	The Third People's Hospital of Hubei Province	Hubei	Wuhan	Comprehensive	2018/12/14
56	Wuhan Hanyang Hospital	Hubei	Wuhan	Basic	2017/12/14
57	Renmin Hospital of Wuhan University	Hubei	Wuhan	Comprehensive	2017/7/22
58	Wuhan ASIA Heart Hospital	Hubei	Wuhan	Comprehensive	2014/12/12
59	Tongji Hospital, Tongji Medical College, Huazhong University of Science & Technology	Hubei	Wuhan	Comprehensive	2015/11/13
60	General Hospital of The Yangtze River Shipping	Hubei	Wuhan	Basic	2017/9/2
61	Wuhan Hospital of Traditional Chinese Medicine	Hubei	Wuhan	Basic	2019/12/12
62	Wuhan Wuchang Hospital	Hubei	Wuhan	Basic	2018/8/6
63	Zhongnan Hospital of Wuhan University	Hubei	Wuhan	Comprehensive	2017/9/2
64	Renmin Hospital of Hunan	Hunan	Changsha	Comprehensive	2017/4/6
65	The Second People's Hospital of Changsha	Hunan	Changsha	Basic	2019/7/14
66	The People's Hospital of Liuyang	Hunan	Changsha	Comprehensive	2019/7/14
67	Changsha Center Hospital	Hunan	Changsha	Comprehensive	2017/12/14
68	Xingsha Hospital of Changsha	Hunan	Changsha	Basic	2021/4/13
69	The Second Xiangya Hospital of Center South Univerity	Hunan	Changsha	Comprehensive	2018/12/14
70	The First Hospital of Changsha	Hunan	Changsha	Comprehensive	2020/9/23
71	Traditional Chinese Medicine Hospital of Liuyang	Hunan	Changsha	Basic	2019/10/31
72	Hunan Aerospace Hospital	Hunan	Changsha	Basic	2019/10/31
73	The Fourth Hospital of Changsha	Hunan	Changsha	Comprehensive	2021/4/13

74	People's Hospital of Chongqing Banan District	Chongqing	Banan	Basic	2017/11/3
75	People's Hospital of Chongqing Qijiang District	Chongqing	Qijiang	Basic	2020/11/16
76	Chongqing Emergency Medical Center	Chongqing	Yuzhong	Comprehensive	2018/3/22
77	People's Hospital of Chongqing Wansheng Economic Development Zone	Chongqing	Qijiang	Basic	2017/4/6
78	Yongchuan Hospital of Chongqing Medical University	Chongqing	Yongchuan	Comprehensive	2017/4/6
79	The People's Hospital of Dazu, Chongqing	Chongqing	Dazu	Comprehensive	2018/12/14
80	Chongqing Fuling Central Hospital	Chongqing	Fuling	Comprehensive	2020/9/23
81	Chongqing Fengdu County People's Hospital	Chongqing	Fengdu	Basic	2018/12/14
82	The First Hospital of Chongqing Medical University	Chongqing	Yuzhong	Comprehensive	2016/7/24
83	Chongqing Fifth People's Hospital	Chongqing	Nanan	Comprehensive	2018/12/14
84	Chongqing Jiangjin District Central Hospital	Chongqing	Jiangjin	Comprehensive	2021/4/13
85	Chonggang General Hospital	Chongqing	Dadukou	Basic	2018/11/2
86	General Hospital of Chongqing Nantong Mining Co.	Chongqing	Qijiang	Basic	2019/4/11
87	People's Hospital of Chongqing Rongchang District	Chongqing	Rongchang	Comprehensive	2020/9/23
88	Chongqing Dianjiang County Hospital of Traditional Chinese Medicine	Chongqing	Dianjiang	Basic	2021/4/13
89	The Third Affiliated Hospital of the Third Military Medical University	Chongqing	Yuzhong	Comprehensive	2017/7/22
90	Chongqing Dianjiang County People's Hospital	Chongqing	Dianjiang	Basic	2019/12/12

Steering Committee

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Working Group

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Table S3. Demographic information of participants.

Participants' characteristics	CPC Directors	CPC Coordinators
Working Year†	21 (15-26)	11 (7-16)
Sex‡		
Male	68 (61.82)	42 (38.18)
Female	19 (34.55)	36 (65.45)
Title‡		
Chief	81 (93.10)	32 (41.03)
Attending	6 (6.90)	43 (55.13)
Junior	0 (0.00)	3 (3.85)
Education‡		
Doctoral	20 (22.99)	10 (12.82)
Master	15 (17.24)	24 (30.77)
Bachelor	52 (59.77)	44 (56.41)

† median (IQR).

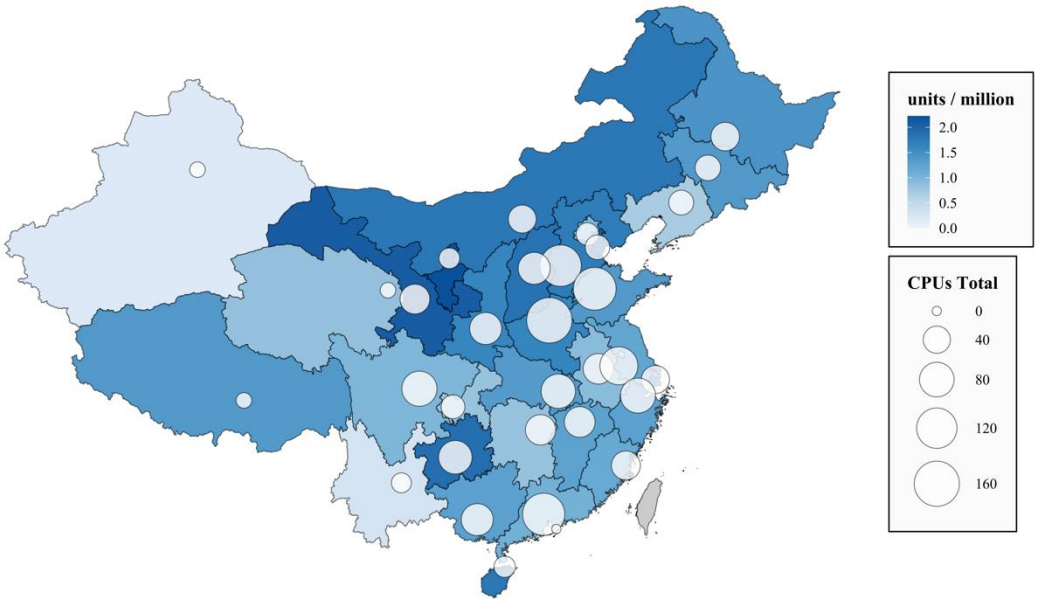
‡ n (%).

CPC, chest pain center.

Table S4. Description of dependent and independent variables by regions.

	Eastern (n=374)	Central (n=369)	Western(n=173)	*P* value
Engagement	2.2 (1.1)	2.4 (1.1)	2.3 (1.0)	0.23
Medical treatment behavior	326 (87.2%)	326 (88.3%)	145 (83.8%)	0.34
Satisfication	196 (52.4%)	191 (51.8%)	80 (46.2%)	0.38
Sustainablility	244 (65.2%)	219 (59.3%)	102 (59.0%)	0.18
Resources	5.5 (0.7)	5.5 (0.8)	5.3 (0.8)	0.06
Barriers	1.6 (1.4)	1.5 (1.3)	1.5 (1.2)	0.31
Motivation	5.8 (0.5)	5.7 (0.6)	5.6 (0.7)	<0.01
Knowing	5.4 (0.7)	5.5 (0.7)	5.3 (0.8)	0.07
Complexity	2.7 (0.9)	2.6 (0.8)	2.7 (0.7)	0.10
Familiarity	3.5 (0.7)	3.5 (0.7)	3.5 (0.7)	0.58

Figure S1. Distribution of CPCs in China.



CPC, chest pain center.