System Barriers to the Evidence-Based Care of Acute Coronary Syndrome Patients in China

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**Background**—Organizational and wider health system factors influence the implementation and success of interventions. Clinical Pathways in Acute Coronary Syndromes 2 is a cluster randomized trial of a clinical pathway–based intervention to improve acute coronary syndrome care in hospitals in China. We performed a qualitative evaluation to examine the system-level barriers to implementing clinical pathways in the dynamic healthcare environment of China.

**Methods and Results**—A qualitative descriptive analysis of 40 in-depth interviews with health professionals conducted in a sample of 10 hospitals purposively selected to explore barriers to implementation of the intervention. Qualitative data were analyzed using the Framework method. In-depth interviews identified 5 key system-level barriers to effective implementation: (1) leadership support for implementing quality improvement, (2) variation in the capacity of clinical services and quality improvement resources, (3) fears of patient disputes and litigation, (4) healthcare funding constraints and high out-of-pocket expenses, and (5) patient-related factors.

**Conclusions**—System-level barriers affect the ability of acute coronary syndrome clinical pathways to change practice. Addressing these barriers in the context of current and planned national health system reform will be critical for future improvements in the management of acute coronary syndromes, and potentially other hospitalized conditions, in China.

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**Key Words:** acute coronary syndrome  ■ quality of health care

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China, a country in the midst of an epidemiological transition, faces many challenges in implementing evidence-based care to curb the growing burden of coronary disease. An aging population and increasing prevalence of cardiovascular risk factors have led to an epidemic of acute coronary syndrome (ACS) across China. Effective therapies for ACS care, however, continue to be variably used with widespread inequities. Furthermore, hospital human resources and adoption of technologies also vary substantially and are particularly limited in rural areas. This suggests the presence of significant barriers to implementing change, yet our understanding of these barriers within the healthcare system of China is limited. Particularly, how system factors, that is, the organizational structures, health policies, and the wider social, economic, and political context, may affect efforts to implement evidence at the point of care is largely unknown.

Understanding these system barriers is critical given their influence on quality of care. Organizational and wider system factors have been consistently shown to have a significant influence on organizational change, success or failure of implementation of interventions, and their effectiveness. For example, in acute myocardial infarction care, differences in organizational values and goals, senior management involvement, and expertise in acute myocardial infarction care have been identified between high- and low-performing hospitals. However, much of our existing understanding about how system factors influence care comes from high-income countries. How they affect care in the unique and dynamic environment of China?

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WHAT IS KNOWN

• A randomized trial of acute coronary syndrome clinical pathways in 75 hospitals throughout China increased adherence to recommended discharge medications but failed to improve other acute coronary syndrome care processes.
• This suggests the presence of significant barriers to implementing change within hospitals in China, although these barriers are poorly understood.

WHAT THE STUDY ADDS

• Multiple organizational and wider system factors seemed to impede both the implementation of the clinical pathway and the achievement of the desired quality standards outlined by the pathway.
• These pervasive barriers may limit the impact of quality improvement efforts in China, including the clinical pathways being implemented by the Chinese Ministry of Health for a range of conditions.

healthcare environment of China is uncertain. Acquiring an in-depth understanding of system-level barriers, in the local context, may facilitate more effective strategies for improving the quality of ACS care. This may also have broader relevance for other low- and middle-income countries, where the influence of system factors on ACS care has been evaluated rarely. Knowledge of these barriers is particularly relevant in the context of recent efforts in China to improve the quality of care. A series of healthcare reforms has targeted improvement in access to care in the face of concerns about limited resources, escalating healthcare costs, and lack of affordability. These health reforms are also ongoing with substantial investment in interventions to improve health outcomes. For example, the Ministry of Health has begun implementing clinical pathways for many conditions in hospitals with the aim of standardizing and improving the quality of care. Knowledge of potential barriers to these efforts may inform health policy innovation and guide development of more effective interventions for ACS care and potentially for other hospitalized conditions.

Clinical Pathways in Acute Coronary Syndromes Phase 2 (CPACS-2) is a cluster randomized trial that evaluated the implementation of ACS clinical pathways with regular audit and feedback of performance in 75 hospitals throughout China. Clinical pathways advocate implementation of standardized strategies to deliver optimal care based on guideline recommendations. The major findings of this evaluation, published in this issue, indicate pathways increased adherence to recommended discharge medications but failed to improve other ACS care processes. We performed a qualitative evaluation in parallel with this intervention, as recommended for evaluation of trials of complex interventions. Our aim was to understand the problems encountered by health professionals and hospitals in implementing these pathways and specifically to examine the system-level barriers to implementing clinical pathways in the dynamic healthcare environment of China.

Methods

Data were collected using in-depth semistructured interviews conducted among health professionals taking part in the CPACS-2 intervention. Ethics approval for the study was obtained from the Human Research Ethics Committees at Cardiovascular Institute and Fuwai Hospital, Chinese Academy of Medical Sciences, and Peking Union Medical College, Beijing, China, and from the University of Sydney, Sydney, Australia (HREC Number: 09–2007/10276). Written informed consent was obtained from each participant.

In-Depth, Semistructured Interviews

Of the 75 participating hospitals, 10 hospitals were selected purposefully based on maximum variability in their success with implementation of the pathways in CPACS-2 midway through the program. Maximum variability sampling is a specific method of purposive sampling used in qualitative research to capture and describe the central themes that are present across heterogeneous participants and settings. For example, in the setting of this study, any common barriers that emerge at hospitals of widely varying success in implementation are of particular value in capturing the central, shared aspects or impacts of the implementation of the CPACS-2 intervention. Success with implementation was assessed based on key performance indicators data collected up to that time from the CPACS-2 study (ie, hospitals that showed improvement in key performance indicators versus those that showed no or minimal improvement). Success with implementation was also assessed based on a subjective assessment of implementation process as determined by the CPACS study coordinators (ie, hospitals where difficulties with implementation were encountered versus hospitals where implementation seemed to occur smoothly).

For selection of participants from each hospital, we targeted individuals involved in the implementation of the pathway as they were the most likely to have an in-depth understanding of the barriers to implementation and achieving the pathway goals. Specifically, we targeted those in key decision-making roles such as the director of the cardiology department. Often participants had multiple roles within hospitals. Participants at some sites included Chinese Society of Cardiology working group members, who had an additional mentoring role in assisting other nearby hospitals to overcome difficulties with pathway implementation. These working group members were requested to comment not only on their hospital but also on barriers they experienced from their involvement at other hospitals. A qualitative survey of health professionals from the participating hospitals had indicated wide awareness and experience with the clinical pathway intervention among health professionals (see Data Supplement).

Interviews were semistructured and aimed at identifying perceived problems with the implementation process and wider systemic barriers. All interviews were conducted by a trained qualitative researcher (Y.F. Wang) who was uninvolved with the CPACS-2 intervention. Forty interviews were conducted on an individual basis, each ≈1 hour in duration, with digital recording in the interviewees’ local Chinese dialect. One interviewee declined to be audiotaped but consented to detailed note taking by the interviewer. Interviews were then deidentified, transcribed, and translated into English for analysis. Back-translation ensured the integrity of the data. Participation in the interviews was voluntary, and participants were free to end the interview at any time. Participants were informed that all responses were strictly confidential.

Data Analysis

Interviews were analyzed using the Framework method, a qualitative analysis technique that is widely used for thematic analysis. The Framework method consists of 5 steps: (1) data familiarization and line-by-line coding of transcripts where codes are used to organize and catalogue key concepts; (2) development of an analytic framework based on the coding of initial transcripts where codes are grouped into categories; (3) indexing or application of the working analytic frame whereby subsequent transcripts are indexed using the newly developed codes and categories; (4) charting of data into the framework matrix whereby data are summarized by category from each transcript; and (5) data interpretation where data are compared and commonalities
and differences are evaluated, leading to the identification of common discourses encompassing multiple and frequently co-occurring themes.

Qualitative data collection and analysis in our study were iterative such that interviews and analyses informed one another. The initial interview guide was developed de novo after discussions among the multidisciplinary research team. It included broad open-ended questions designed to facilitate discussion on potential barriers to implementation. The guide was further modified based on interview data collected from the first 4 hospitals and after analyses of data collected after the first 7 hospitals (see Data Supplement for sample questions included in the interview guide). Furthermore, in keeping with the Framework method,16–19 both coding and the development of the initial analytic framework were a dynamic and iterative process where the researchers (I.R., Y.R., D.X., Y.F. Wang, and F.T.) compared and contrasted emerging codes and categories with prior codes and categories to ensure they reflect the same concept. All discrepancies in coding and interpretation were discussed among the researchers, with disagreements resolved by consensus. Visiting and revisiting the data, collecting additional information and clarifying concepts by modifying the questionnaire, and connecting findings with emerging insights progressively lead to a refined understandings of key themes. All translated interviews were coded using NVivo v8.0 (QSR International, Victoria, Australia).

Results

Key Themes Characterizing System-Level Influences

Based on thematic analysis of the in-depth interviews, we identified 5 key themes that characterized perceived system-level influences on the implementation of the intervention and which could potentially explain the main evaluation findings.

Leadership and Support for Implementing Quality Improvement

Organizational leadership and support for implementing quality improvement (QI) were consistently reported as highly important for achieving change within hospitals. Lack of support was associated with poor allocation of resources for the intervention (staff, funding), lack of advocacy within the hospital, and difficulties with coordination. Where hospital or departmental leaders valued the intervention and where there was visible leadership support (eg, ongoing discussions with clinicians, engagement with data analysis and reporting), there was a markedly positive effect in increasing enthusiasm and engagement in the pathways by other clinicians. Greater authority and seniority were also raised as important to achieving change and were closely related to the hierarchical leadership structure prevailing in most hospitals.

I think one of the reasons [for doing well in the project] is that our leaders highly value it. This is very important. Our leaders from Hospital Director [name] to Director [name] all highly value this project. And we are very strict in the clinical activities and assigned dedicated persons to be responsible for them. And we also organize meetings regularly. If there are any problems or anything that is not done quite well, our leaders would criticize us and ask us to make the corresponding rectifications.

Hospital Coordinator

Many participants perceived making changes to hospital systems or processes based on data audit and feedback as too difficult in the absence of high-level administrative support.

In this context, government directives were thought to have an influence on organizational leadership and supported implementation. For example, administrative orders were prioritized by hospital leaders. Although some clinicians had reservations about such directives, many noted the impact of these on the pace of change in systems and processes, including overcoming individual and departmental disagreements.

It [the intervention] can be better managed in our hospitals if such administrative rules can be established by the Ministry of Health. This is because in China, the interference [influence] from the government plays a very important role.

Hospital Coordinator

Variation in the Capacity of Clinical Services and QI Resources

Hospital services varied widely, and some lacked the resources required to satisfy guideline recommendations. For example, emergency departments varied in their capacity to provide acute services, such as thrombolysis. Although many hospitals developed methods to overcome these (such as the transfer of patients to the coronary care or intensive care unit before initiation of therapy), these strategies were inevitably associated with delays to treatment. Suboptimal access to cardiac catheterization facilities was attributed to limited and overburdened facilities, resulting in further delays to urgent treatments (such as primary percutaneous intervention for ST-segment-elevation myocardial infarction). Underuse of primary care and outpatient follow-up services was identified as a major barrier to patient follow-up and, as a consequence, to adherence with guideline-recommended therapy after discharge.

The patients can only be treated with such treatments as thrombolysis, pain relieving with morphine or intensive cares after they have been admitted. Such treatments are not given in the emergency department. We don’t have such conditions there [emergency department]. We cannot perform thrombolysis there. It is generally the case in all county level hospitals.

Hospital Doctor

Limited resources allocated to QI were consistently raised as a major barrier for implementation. Adequate knowledge, staff, time, funding, and administrative support were required for implementation of the CPACS-2 intervention but were lacking in many hospitals. Data collection, analysis, and patient follow-up as per study protocol were frequently delegated to students or junior clinicians, often in addition to existing academic studies or clinical workload. Insufficient resources hindered the pathway promotion (organizing meetings, educating and training clinicians) and implementation.

It [the intervention] is beneficial to both the doctors and the patients. However, it is rather difficult to actually do it. It is rather difficult if you are to consistently stick to it in a standard way. Many cooperation and many facilities [resources] need to be supplied. You need to have the people to carry it out.

Hospital Nurse
The local QI team was required to address deficiencies in performance, based on the feedback of audit data, including potential changes to their hospital systems. However, participants commented that they were unclear about how to go about making change and often lacked the resources to do so. This may partially explain why some care processes requiring complex system modification such as strategies to improved time to reperfusion therapy were unchanged with the intervention.

Healthcare Funding Constraints and High Out-of-Pocket Expenses

High out-of-pocket expenses for patients and funding constraints were major influences achieving targets recommended by the pathway. Many newer medications (eg, glycoprotein IIb/IIIa inhibitors) were expensive and largely unavailable in smaller hospitals. Even many conventional therapies did not fall within restrictive medical insurance criteria for eligibility. For example, statins could only be prescribed for those with hyperlipidemia, although current ACS guidelines recommend the use of stains in all patients with ACS, regardless of the lipid level, in the absence of contraindications. These restrictions lead to limited treatment options in hospitals and early discontinuation of treatments by patients.

We are under the new rural cooperative medical care system. Many kinds of medications, such as clopidogrel, cannot be reimbursed under this system. And only enalapril can be reimbursed among the ACEI medications. And statins can only be reimbursed when they are used in patients with high blood lipid. There are many restrictions.

Hospital Doctor

The subsequent secondary prevention and the long term medication of coronary heart disease are all very costly. Quite some of the patients cannot continue the medication continuously. They just withdraw the medicines when they go back home if they feel they are OK.

Hospital Doctor

High treatment cost was a major barrier to receiving timely access to life-saving reperfusion therapy for ST-segment-elevation myocardial infarction. Primary percutaneous coronary intervention costs are high relative to income, and many sites indicated the need for patients to make a deposit or agreement on payment before initiating therapy. Delays resulting from such initial financial discussions with the patient and family, the time taken to organize funds, and the fee-paying procedures were all consistently identified as major causes of delays in receiving reperfusion therapy or lack of reperfusion therapy altogether.

It is impossible for us to control the treatment time. The optimal treatment time is missed for many of the patients. And there are many kinds of objective factors. And there are also many economic factors. The patient may not be able to bear the cost for such treatment as PCI... we suggested the PCI treatment which is very suitable for the patient. However, the financial situations of the patient do not allow the patient to receive this treatment. No one is going to reimburse the cost. So we cannot perform PCI for the patient. So we are restricted by many factors.

Hospital Doctor

Hospitals received greater reimbursement for hospitalized patients, and patients were more likely to be reimbursed if they were hospitalized, creating a strong disincentive for early discharge of patients as recommended by the pathways.

Some of the costs can be reimbursed if they [patients] are hospitalised and they may not be able to be reimbursed if they are not hospitalised. So they will not leave the hospital even if you ask them to. They insist to stay in the hospital. You can do nothing about it. This is a big problem. The biggest problem here is about the cost.

Hospital Doctor

Effects of funding constraints were not limited to patients. Some participants suggested that the low base salaries paid to health professionals resulted in the need for additional payments from hospitals. Clinicians were rewarded for quantity of care, rather than necessarily quality of care, with the payment system encouraging doctors to perform more treatment and procedures, which generated more financial reward from the hospital. Clinicians alluded to an increasing level of mistrust among patients on the financial motives of hospitals.

It was a case of acute myocardial infarction. And I said, “you need to be hospitalized immediately.” And then the family member of the patient said many ugly words. They said that the disease was not that serious and we were playing tricks to get their money.

Hospital Doctor

Some participants suggested the need for considerable insurance reform and policy innovation to improve the quality of care.

Professor [name] has proposed the cost for one stent shall be reimbursed for each myocardial infarction patient with raised ST segment for who PCI is performed... This is a good thing. It can be of great help even if the cost of one stent is reimburses. However, it just cannot be reimbursed.

Hospital Coordinator

The cost is especially a problem. This cannot be solved by our doctors. It is about the issue of improving the macro-environment for medical services.

Hospital Doctor

Fears of Patient Disputes and Litigation

Participants commented on the increasing risk of litigation in China. Fear of disputes with patients and possible consequences of litigation and negative publicity for clinicians and hospitals has a major influence on treatment approach. Clinicians were risk-averse with excessive investigation to confirm the diagnosis, despite potential harm or cost to patient, for example, performing coronary angiography in low-risk patients despite availability of noninvasive testing.
They are low risk patients and not no-risk patients. The risks are just comparatively lower. If you did not let them have the treatment [angiography] and later on something happened, they can come to you. There are problems in such areas.

Hospital Coordinator

Participants commented on the avoidance of treatments where there was perceived to be a significantly increased risk of potential death or complications (eg, thrombolysis, percutaneous coronary intervention in high-risk patients), despite therapy being medically indicated with a favorable risk–benefit ratio.

Of course, thrombolysis is not performed very often in hospitals of our level [level 2] in some places... they [clinicians] may think that there are risks in doing this [thrombolysis], so they just don’t do it.

Hospital Coordinator

Patient complaints were likely to occur if a patient died or had an adverse event after a treatment or procedure, even if this may have been because of the patient’s condition. This posed a major ethical dilemma for clinicians attempting to deliver high-risk but life-saving interventions.

It would be your problem [medico-legal dispute] if you do not take any salvaging [lifesaving] actions and it would also be your problem if you fail in saving the patient’s life after having taken the salvaging actions. What shall we doctors do?

Hospital Doctor

Some participants thought the pathways provided justification for certain treatments and therefore provided protection for clinicians in the event of an adverse outcome. However, some feared that documentation of care inconsistent with pathway recommendations may initiate litigation claiming pathway-based care would have avoided harm.

From the point of view of a patient, he or she can lose his or her life without proper treatment. ... And there are many such cases. So if we can define everything in a pathway and everybody is following the rules it can provide a kind of protection to doctors and hospitals.

Working group member

Once a patient of myocardial infarction presents at a hospital, if it is recorded in the time table that no thrombolysis is performed, no interference [interventional] therapy is used and there are no explanations about what is not done and no contraindications are recorded, this can cause problems. This can cause very big problems. The risk is very big. You will definitely lose if a lawsuit is initiated. This is the problem from the point of view of a hospital.

Working group member

Patient-Related Factors

Although patients were not interviewed, clinicians thought that limited patient understanding of coronary disease prevention might contribute to the discontinuation of medications after discharge. Clinicians also suggested that some patients perceived ACS not as a manifestation of a chronic condition but as an acute reversible illness without requirements for continuing long-term therapy.

We are treating ordinary [local common] people. Some of them are from rural areas. And their view on this [disease] is still the old one. This makes it very hard for them to continue the medication after having been treated in the hospital.

Hospital Doctor

Cultural values and norms were also raised as a barrier. Discussion with the wider family was often sought before consent for treatments. Elderly patients would often defer their decision to children or other relatives. Prolonged discussions and the need to wait for other family members to arrive were often raised as contributing factors to delays to timely treatment.

They [patient] may say that the decision cannot be made by them alone and the decision should be made by all the family members. This may be caused by the traditional Chinese way of thinking. We cannot do anything in such cases.

Hospital Doctor

Discussion

The formal evaluation of the CPACS-2 program, reported in this same issue, showed that the use of clinical pathways improved some but not all aspects of the quality of care provided to patients with ACS in China. This qualitative study, conducted in parallel, sought to capture the opinions of a range of health professionals involved in the program and explored the reasons for its limited success other than those that might be related to insufficient study power. Our findings suggest the presence of multiple organizational and wider system factors, which often countered both the implantation of the clinical pathway and the achievement of the desired quality standards outlined by the pathway. These widespread and pervasive healthcare barriers are likely to limit the impact of future QI efforts in China, including the clinical pathways being implemented by the Chinese Ministry of Health for a range of conditions.12

The complex interplay of system factors on care delivery was most evident with regard to access to life-saving reperfusion therapy. Nearly 60% of patients in the CPACS-2 trial failed to receive any form of reperfusion therapy, despite timely presentation to hospital. Those who received reperfusion therapy had exceptionally prolonged treatment delays well outside of acceptable benchmarks.20 Our findings show that limited capacity of hospital emergency care services, high out-of-pocket expenses with the need for up-front payment, prolonged discussions with the patient and families for both obtaining consent and pooling funds, and avoidance of treatments in patients perceived to be high risk of adverse outcomes are likely to be major contributing factors. The failure to provide these treatments in a timely manner, including readily available and relatively low-cost therapies such as thrombolysis, is indicative of the magnitude of influence these barriers have on delivery of best practice care.
Our findings indicate the need for concurrent investment in improving the structural capacity of hospitals to achieve optimal outcomes. For example, the capacity of hospital emergency services, an essential structural prerequisite to deliver best ACS care, varied considerably among CPACS-2 hospitals and indeed varies considerably in China. Although some emergency departments are highly advanced with autonomous function, most have limited capacity to provide essential treatments. Lack of standardization of emergency care, limited funding, and insufficient numbers of qualified emergency staff have been identified as contributing to such variation. Similarly, systems and resources to support QI varied across hospitals participating in CPACS-2. Future quality initiatives will need to address these structural limitations without which substantial improvement in care is unlikely to be achieved.

High patient out-of-pocket costs were also consistently identified as an important barrier to care. In China, hospitalization alone has been estimated to cost as much as 4 to 7× the annual income, with out-of-pocket payments comprising 58% of China’s total health spending. Many evidence-based interventions, such as percutaneous coronary intervention and novel drugs, are placed beyond the reach of many patients. The failure to improve door-to-balloon times was attributable, in part, to the need to make up-front payments associated with invasive therapies. Similarly, treatment rates with clopidogrel and statins have been shown to be 6.7% and 34.2%, respectively, in patients with the lowest socioeconomic status and 41.7% and 75%, respectively, in patients with the highest socioeconomic status. Recent health reforms have reduced out-of-pocket payments by providing wider insurance cover and establishing a national essential medication system. These policy changes may help reduce the sometimes catastrophic costs of ACS to individual patients and households.

Our study indicates that the success of a QI intervention is contingent on leadership support. A lack of support for QI from leaders within the hospital or political and administrative endorsement from relevant government agencies was identified as a major barrier. These findings are consistent with a recent qualitative study conducted in US hospitals ranked as the top 5% and bottom 5% of performers in acute myocardial infarction care, which demonstrated that the quality of care afforded to patients suffering from acute myocardial infarction differed according to the level of involvement by a hospital’s senior management and governing board. In particular, the presence of senior management demonstrating unwavering commitment to high-quality care was a common feature of high-performing hospitals. Strong leadership also promotes a positive organizational culture and system that support a coordinated approach to care and foster engagement and good communication among the entire clinical team. Empowering clinical leaders and collaboration with government as well as relevant professional organizations may greatly facilitate future initiatives.

In-depth interviews identified the lack of systems for handling medico-legal consequences of implementing best practice care. The suggested risk-averse behavior may explain the lack of improvement in high-risk patients undergoing coronary angiography, the limited number of low-risk patients undergoing functional testing, and the limited use of thrombolysis. Risk-averse practice, especially with invasive care, is not limited to China and has been documented globally. Although routine use of risk–benefit analysis to aid medical decision making is widely advocated for optimal care, this is not actively encouraged in China nor are doctors legally protected from consequences related to any risks of medical treatments. Comprehensive professional medical indemnity schemes, proposed as a component of healthcare reforms, may affect positively on the quality of care provided to patients with ACS in the future.

There are several strengths and limitations to this study. The qualitative design allowed analysis of the complex barriers to organizational change and the influence of social interactions, organizational culture, and wider socioeconomic concerns, which are difficult to capture quantitatively. We focused on identifying the barriers to implementation and improvement in ACS care rather than the enabling factors and did not include an assessment of patients’ views of the barriers to improved care, which are both limitations of this study. However, to enhance the validity and reliability of our findings, we used several techniques such as audiotaping and professional transcription of interviews, and back-translation to ensure the transcripts captured the intended meaning, and involvement of multiple investigators from varying backgrounds in the analysis and discussion process. In addition, we conducted detailed interviews with multiple staff in each hospital from several different hospitals. Despite these analytic safeguards, the study remained descriptive and interpretive and is hypothesis generating. Future quantitative studies are needed to evaluate whether addressing system-level barriers identified by these themes would improve process indicators and clinical outcomes.

Conclusions

ACS clinical pathways are acknowledged widely as beneficial, yet multiple organizational and wider system factors often countered both the implantation of the clinical pathway and the achievement of the desired quality standards outlined by the pathway. Addressing these barriers in the context of current and planned national health system reform will be critical for future improvements in the management of ACS and potentially other hospitalized conditions in China.

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Disclosures

Dr Gao and Dr Patel have support from Sanofi-Aventis for the submitted work. No author has relationships with companies that might have an interest in the submitted work in the previous 3 years. Their spouses, partners, or children have no financial relationships that may be relevant to the submitted work, and no authors have nonfinancial interests that may be relevant to the submitted work. The other authors report no conflicts.
Appendix

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References


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SUPPLEMENTAL MATERIAL

SYSTEM BARRIERS TO THE EVIDENCE-BASED CARE OF ACUTE CORONARY SYNDROME PATIENTS IN CHINA: A QUALITATIVE ANALYSIS

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Yangfang Wang, MD, PhD, Runlin Gao, MD, FACC, Anushka Patel, MBBS, SM, PhD,
Yangfeng Wu, MD, PhD, Rick Iedema, PhD, Zhixin Hao, MD, Dayi Hu, MD, FACC, Fiona
Turnbull, MBChB, MPH, PhD, on behalf of the CPACS Investigators

Supplementary Material Contents:

1. A summary of the primary findings of the CPACS-2 intervention

2. A survey of Health professionals who took part in the CPACS-2 intervention

3. Sample interview guide

   All interviews were semi-structured. The interview questions were broad and were
designed to initiate in-depth discussion. modified based on interview data collected from
the first 4 hospitals and following analyses of data collected after the first 7 hospitals.
1. Effects Of Clinical Pathway Intervention on Key Performance Indicators (Randomised Evaluation).

<table>
<thead>
<tr>
<th>Key performance indicators</th>
<th>Intervention hospitals</th>
<th>Control hospitals</th>
<th>Adjusted odds ratio or mean difference</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of stay, days mean (SD)</td>
<td>12.0 (9.0)</td>
<td>11.3 (7.4)</td>
<td>0.76 (-.63, 2.14)</td>
<td>0.2875</td>
</tr>
<tr>
<td>Door-to-needle time for STEMI patients undergoing thrombolysis, mins mean (SD)</td>
<td>79.1 (66.2)</td>
<td>99.0 (81.4)</td>
<td>-18 (-50, 13.4)</td>
<td>0.3064</td>
</tr>
<tr>
<td>Door-to-balloon time for STEMI patients undergoing primary PCI, mins mean (SD)</td>
<td>141.5 (104)</td>
<td>130.1 (91.0)</td>
<td>11.6 (-23, 46.1)</td>
<td>0.5149</td>
</tr>
<tr>
<td>Patient with final diagnosis (UAP or MI) consistent with biomarker finding, %</td>
<td>89.2</td>
<td>92.7</td>
<td>0.71 (0.40, 1.24)</td>
<td>0.2514</td>
</tr>
<tr>
<td>Low-risk patients undergoing functional testing, %</td>
<td>1.2</td>
<td>6.3</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>High-risk patients undergoing coronary angiography, %</td>
<td>51.1</td>
<td>45.7</td>
<td>1.26 (0.66, 2.40)</td>
<td>0.4856</td>
</tr>
<tr>
<td>Patients discharged on appropriate medical therapy, %</td>
<td>61.6</td>
<td>51.3</td>
<td>1.39 (0.99, 1.94)</td>
<td>0.0607</td>
</tr>
<tr>
<td>Patients arriving within 12 hours of symptom onset who received reperfusion therapy, %</td>
<td>42.6</td>
<td>31.8</td>
<td>1.48 (1.02, 2.14)</td>
<td>0.0657</td>
</tr>
</tbody>
</table>

Footnote: Effects of the clinical pathway intervention on binary and continuous key performance indicators in the randomized comparison of intervention hospitals (Group A at 12 months) compared with control hospitals (Group B pre-intervention). Risk ratios and mean differences expressed as unadjusted estimates. Variables adjusted for include hospital level, gender, main occupation (manual or business), insurance status, family history of premature coronary heart disease, previous diagnosed stroke or transient ischemic attack and smoking history. Denominators vary according to patient subgroup. Abbreviations: NC=
No compared, SD = standard deviation, STEMI = ST elevation myocardial infarction, UAP = Unstable angina pectoris.

2. Survey of Health Professionals

Health professionals working in relevant departments in the 75 participating hospitals were invited to take part in the survey which assessed their perceptions, experiences, and the degree of engagement with the pathway intervention. Each hospital was requested to provide a list of health professionals directly using the pathways or involved in their implementation. These individuals included doctors working in emergency departments, cardiologists and other physicians working in inpatient and outpatient departments, nurses, and senior departmental and hospital administrators. The survey comprised of open- and closed-ended questions as well as 6-point Likert scale questions. Hard copies of the survey with reply-paid envelopes were mailed directly to each identified health professional and de-identified forms were returned directly to the study coordinating centre. Responses were received from 71 of the 75 hospitals. More than 90% of questionnaires were returned from each hospital. Quantitative survey and data were analyzed using SPSS v17.0 (SPSS Inc., Chicago, USA) and presented as frequencies and percentages.

Awareness and Experiences of the Intervention Among Health Professionals

Characteristics of the 556 respondents who completed the health professional’s survey are listed in Table 1. Most (78.3%) were physicians aged between 21-40 years. Awareness of the intervention was high (Figure 1); 98.2% of respondents had heard of the intervention, and over 80% had attended training sessions, used the pathway in clinical practice, and were aware of study reports. Health professionals’ experience of the clinical pathways was very positive (Figure 2). Over 90% of respondents completely or strongly agreed that the pathways were valuable for the management of ACS patients and that the programme was important for improving quality of care.
Table 1: Survey of Health Professionals - Respondent Characteristics (n=556)

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-30</td>
<td>190</td>
<td>34.0</td>
</tr>
<tr>
<td>31-40</td>
<td>247</td>
<td>44.3</td>
</tr>
<tr>
<td>41-50</td>
<td>101</td>
<td>18.1</td>
</tr>
<tr>
<td>51-60</td>
<td>18</td>
<td>3.2</td>
</tr>
<tr>
<td>61+</td>
<td>2</td>
<td>0.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>269</td>
<td>48.4</td>
</tr>
<tr>
<td>Female</td>
<td>287</td>
<td>51.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Current Position</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiologist</td>
<td>397</td>
<td>71.4</td>
</tr>
<tr>
<td>Other Physician</td>
<td>56</td>
<td>10.1</td>
</tr>
<tr>
<td>Nurse</td>
<td>69</td>
<td>12.4</td>
</tr>
<tr>
<td>Hospital Administrator</td>
<td>11</td>
<td>2.0</td>
</tr>
<tr>
<td>Other</td>
<td>24</td>
<td>4.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Duration of Employment</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1 year</td>
<td>37</td>
<td>6.6</td>
</tr>
<tr>
<td>1-5 years</td>
<td>170</td>
<td>30.6</td>
</tr>
<tr>
<td>6-10 years</td>
<td>124</td>
<td>22.3</td>
</tr>
<tr>
<td>10-20 years</td>
<td>154</td>
<td>27.7</td>
</tr>
<tr>
<td>20+ years</td>
<td>72</td>
<td>12.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Highest Level of Education</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD</td>
<td>66</td>
<td>11.9</td>
</tr>
<tr>
<td>Masters</td>
<td>196</td>
<td>35.2</td>
</tr>
<tr>
<td>Bachelor</td>
<td>217</td>
<td>39.0</td>
</tr>
<tr>
<td>Diploma</td>
<td>64</td>
<td>11.5</td>
</tr>
<tr>
<td>Under-Diploma</td>
<td>7</td>
<td>1.3</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
<td>1.3</td>
</tr>
</tbody>
</table>

Figure 1: Awareness of the CPACS-2 Intervention Among Health Professionals
Heard of the CPACS-2 intervention
Attended the CPACS-2 training sessions
Used the pathways in clinical practice
Aware of the CPACS-2 summary (audit) reports
Aware of the results from these reports
Involved in the discussions regarding pathway modification

Awareness of the CPACS-2 Intervention Among Health Professionals

Proportion (%) of survey respondents (n = 556)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Yes response</th>
<th>No or missing response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heard of the CPACS-2 intervention</td>
<td>90%</td>
<td>10%</td>
</tr>
<tr>
<td>Attended the CPACS-2 training sessions</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>Used the pathways in clinical practice</td>
<td>70%</td>
<td>30%</td>
</tr>
<tr>
<td>Aware of the CPACS-2 summary (audit) reports</td>
<td>60%</td>
<td>40%</td>
</tr>
<tr>
<td>Aware of the results from these reports</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>Involved in the discussions regarding pathway modification</td>
<td>40%</td>
<td>60%</td>
</tr>
</tbody>
</table>
Figure 2: Health Professional's Experiences of the CPACS-2 Clinical Pathway Intervention.

Health Professional's Experiences of the CPACS-2 Clinical Pathway Intervention

Proportion (%) of survey respondents (n=556)

- The program is important for improving quality of care
- The program is valuable for management of ACS patients
- The program is realistic in practice
- The program is easy to follow
- The clinical pathways are helpful reminders for following the guidelines
- The clinical pathways should continue to be used.
- The hospital reports are valuable for directing practice
- The program is well organised in my hospital
- I received good support from the project leader/coordinator

Legend:
- Blue: Completely Agree
- Green: Strongly Agree
- Orange: Agree
- Red: Disagree
- Black: Strongly Disagree
- Yellow: Completely Disagree
2. Sample interview guide

1) Background
- What is your role in the hospital
- What is your responsibility in providing cardiology service?
- How long have you worked in the area?
- What responsibilities do you have other than CPACS Pathway?

2) CPACS-2 experience
- How did you learn about CPACS-2?
- What do you understand about the program?
- Did you use the clinical pathways? Why?
- What are the drawbacks and benefits for you to apply the clinical pathways?
- Have you heard about the key performance reports on the management of ACS patients in your hospital? If yes, what did that tell you? How did that influence your practice? Why?
- Were you involved in the discussion on modification of clinical pathways in your hospital? If yes, what did you discuss? If no, why?

3) CPACS-2 local organisation
- How was your QCI team established?
- Who are they in your QCI team? What are their titles in their jobs? What are their roles in CPACS-2?
- How did you plan to organise the implementation of the program at your hospital or department?
- What training or learning session on CPACS-2 did you have? Was that among QCI team members or relevant clinicians?
- What support did you have from senior level of your department (or hospital)?
- How did the members in QCI team work together for CPACS-2?
- What do you think about the centre reports? How did you talk about it with the team members and the relevant health professionals?
Did you discuss anything about CAPACS-2 with the assigned working group member? What did you discuss? Do you think it is helpful? Why?

What did you do to encourage health professionals’ involvement and using the clinical pathways?

3) Implementation Barriers

Were there difficulties in the process of implementation? What are they? If yes, what are they?

Did they get solved? If yes, how were they solved? If no, what is the situation now, as far as you know? Why?

What do you think about the program in general? Why do you think so?

Is there anything that you think would improve the program itself or its implementation? How could it be better?

Is there anything else you would like to add about the program?

Questions for working group members

1) Experience with CPACS-2

Have you talked about CPACS-2 with the QCI teams of the hospitals that were assigned to you? If no, why?

(Ask the interviewee to think about two example hospitals: one that he/she works well with and one that he/she had difficulty to work with, and talk about each of them)

What level is the hospital?

How would you describe the hospital’s condition and environment?

How did you work with the QCI team of the hospital?

Did you discuss about the clinical pathways with them? If yes, what did you discuss?

Did you discuss their centre reports with them? If yes, what did you discuss?
• Do you think the discussion is helpful for them to improve the management of ACS patients? Why?

2) Barriers and comments (For each hospital mentioned)
• Were there any difficulties between you and that QCI team? If yes, what were they? How were they solved?
• What do you think about the program in general? Why do you think so?
• Is there anything that you think would improve the program itself or its implementation? How could it be better?
• Is there anything else you would like to add about the program?