



HeartRescue Global

INDIA • CHINA • BRAZIL

# HeartRescue Global Final Report

Improving Access and Quality of Care for Acute Cardiovascular Disease in India, China, and Brazil



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# Executive Summary

## A. Background and Goals

Countries around the world are facing an *[increasing burden of cardiovascular disease](#)*.<sup>1</sup> The goals of the HeartRescue Global (HRG) project were to improve access and quality of care for patients with severe heart attacks, known as ST-elevation myocardial infarctions (STEMIs).

Timely STEMI treatment is associated with significantly improved survival rates and other positive patient outcomes and reduced health care costs. Time to treatment for someone suffering a STEMI event is a matter of life and death. The amount of heart muscle lost from lack of blood supply with STEMI is directly related to the length of time from symptom onset to definitive treatment. However, many countries lack systems of care to provide effective STEMI treatment, particularly low- and middle-income countries that have many fewer health care system resources per capita.

HRG was conceptualized by the Medtronic Foundation following 5 years of success with the HeartRescue United States (US) program. HeartRescue US focused on reducing mortality caused by cardiac arrest. It started in five states and, at the time of this report, has now expanded to a total of 17 states.

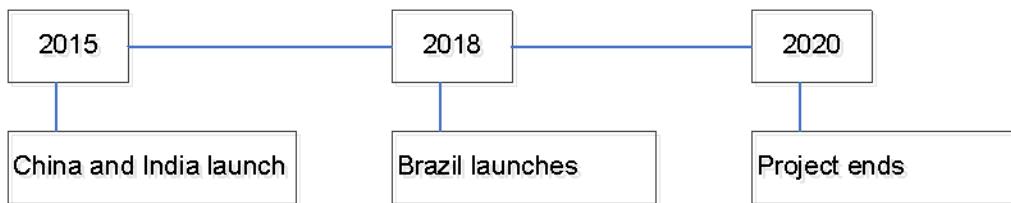
**Who was involved in HRG?** RTI International served as the Medtronic Foundation's implementation partner for HRG, which lasted from 2015 to 2020. HRG was implemented in three middle-income countries:

- HeartRescue India (HRI) in Bangalore, India, led by the Ramaiah Medical College and the University of Illinois at Chicago.
- HeartRescue China (HRC) in Suzhou, China, led by RTI International in partnership with the China Heart House, the operational arm of the China Cardiovascular Society.
- HeartRescue Brazil (HRB) in Vitória da Conquista (VDC), Brazil, led by the Brazilian Clinical Research Institute in partnership with the Federal University of Bahia.

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<sup>1</sup> The bold blue italicized text on this page and the following pages are hyperlinks to HeartRescue Global Policy Briefs that provide more information on these topics.

### Timeline for HeartRescue Global



Each of the country programs also had multiple local partners in governments, hospitals, emergency medical services (EMS) agencies, community groups, schools, and businesses. The Institute for Health Metrics and Evaluation (IHME) independently analyzed the program.

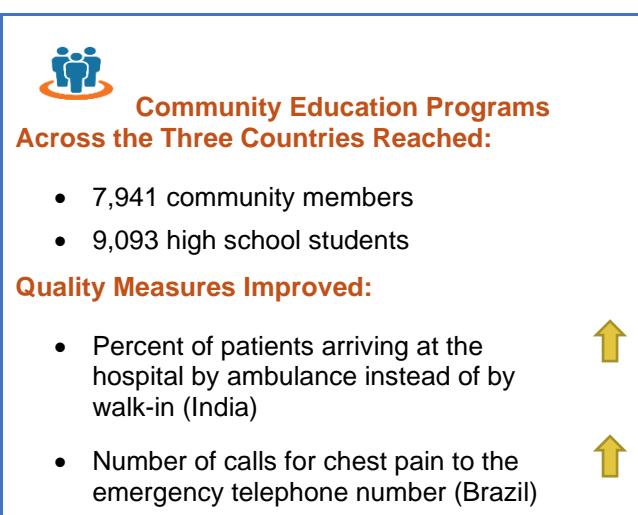
## B. Focus on Improving Systems of Care

HRG addressed barriers to access and quality of care for STEMI patients from the time they begin experiencing heart attack symptoms at home or in the community, through EMS response when called, and then during treatment in hospitals. These three settings form the [system of care](#) that affects STEMI treatment.

HRG used STEMI patient registries in each country to collect quality improvement data and patient demographics to monitor changes over time as each country implemented interventions in each setting in the system of care. The registries included 2,037 STEMI patients across the three countries. The data also captured disparities in access and quality of care for underserved groups. IHME developed an online data visualization tool to collect and display the quality measure data on a monthly basis, analyze demographics and other factors, track trends over time, and identify opportunities for improvement.

## C. Impact

**Community setting.** Each HRG site conducted community education programs with adults and high school students to [raise awareness of STEMI symptoms](#) and the need to call emergency telephone numbers to get medical care quickly. HRB built on an existing public



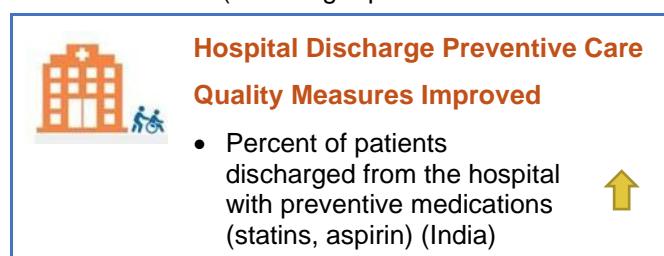
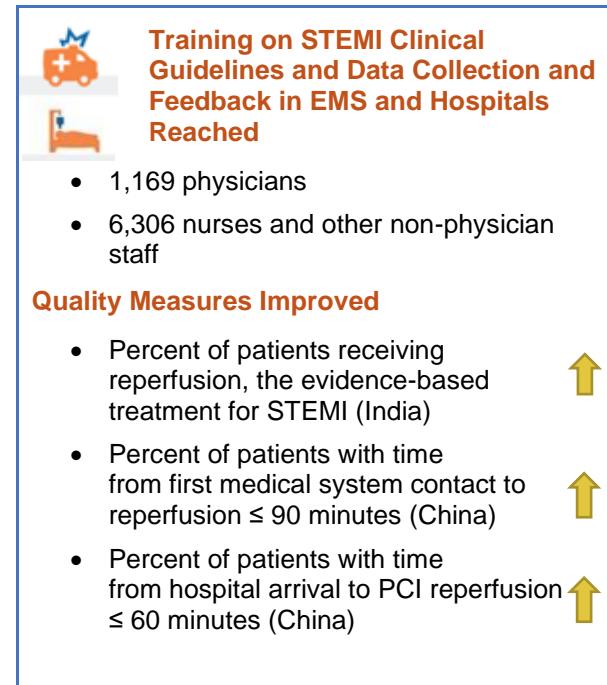
health infrastructure of community health workers and conducted training in local schools. HRC developed social media campaigns in addition to in-person education events. HRI set up help desks at hospitals, conducted in-person education events, and incorporated training in 10 schools for 8th and 9th graders.

**EMS setting.** HRG spurred infrastructure development to promote rapid EMS response: HRI developed a new nurse-paramedic motor scooter ambulance system to navigate through heavy city traffic faster than traditional ambulances, and HRB restarted a “Motolance” motorcycle ambulance system. HRC coached EMS dispatchers on how to speak with callers reporting STEMI symptoms, and all sites coached on [clinical guidelines for STEMI care](#) and worked [toward integrating data systems](#) between the EMS and hospital settings.

**Hospital setting.** Hospital training on STEMI clinical guidelines included emergency departments and cardiology. Quality improvement data on processes and time to critical STEMI care (receiving reperfusion treatment) were a focus for discussing the process of care changes that could lead to greater improvement on the quality measures with clinicians.

## D. Lessons Learned and Recommendations

**Improve access for women to STEMI care.** The STEMI patient registries for all three of the sites showed that fewer women than men were treated. Women represented only 16% of the STEMI patients in the HRC patient registry, 22% of the STEMI patients in the HRI patient registry, and 28% of the STEMI patients in the HRB patient registry. At the same time, the quality measures showed similar results for both women and men who did receive treatment in the HRG programs. The underlying reasons for this gender disparity—which could include knowledge, health-seeking



behaviors, costs of care to families, and others—will need to be studied in more detail in each country and community to design additional interventions to improve access for women.

***Training offers valuable skills to health care workers but leads to challenges for retaining them.*** Problems with staff turnover often resulted from the new skills they gained through HRG training, which made them more marketable for new jobs that offered higher pay. More effective ways for motivating staff to remain in their jobs will need to be part of the interventions for future programs. These could include planning for career development pathways, developing a pipeline of new staff to fill roles when turnover occurs, and others.



*HeartRescue India training for hospital staff*

***Identify achievable treatment goals.*** HRG was initiated with a focus on cardiac arrest, following the HeartRescue US program. However, we realized early on that community awareness and response, EMS systems, and hospital infrastructures in all three HRG countries were not yet ready to tackle the problem of cardiac arrest, which requires a very short response time of 10 minutes or less. STEMI has a longer response time required of about 3 hours, and this was more realistic for the HRG middle-income countries that had many fewer health care system resources per capita than the United States or other high-income countries.

***Plan for major data collection and data quality challenges.*** We encountered a number of data collection and data quality problems. They included missing data caused by lack of data in medical records and time constraints of busy staff, difficulty in follow-up for patients transferred to other hospitals, limited funds for data collection in the partner

hospitals and EMS agencies, turnover of staff trained in data collection, and software challenges for collecting and transmitting data. IHME provided automated reports to identify missing data and out-of-range values that aided data quality control and improvement, but additional data quality control and more intensive follow up to fix data problems should be planned for future programs.

***Identify effective ways to change community knowledge, attitudes, and behaviors.*** We were not able to achieve as much improvement in the community setting quality measures as we had hoped. Future programs should place a higher priority on investigating community knowledge, attitudes, and behaviors from the outset. Additional types of community interventions should also be tested in future programs. Improved health insurance coverage, more convincing assurances about the lower cost of subsidized or free care, more intensive outreach through primary care doctors or community health workers, more intensive communications efforts, and expanded use of social media are several possible approaches. Detailed qualitative research through interviews and focus groups with patients and families would help to better understand the cultural barriers, financial barriers, and fears associated with seeking EMS and hospital care.



*HeartRescue Brazil community health workers*

***Cover the complete range of disease processes.*** We included interventions to address delays in the community in seeking care and not just delays in getting patients to treatment once they had their first contact with the medical system through EMS or a hospital. Many STEMI programs in the United States and other high-income countries

focus interventions only on reducing the time from first medical system contact to treatment, because people in those countries are usually quick to call emergency telephone numbers, and improvements in care-seeking behavior in the community are viewed as more difficult to achieve by medical professionals. For the middle-income countries in HRG, we found that many STEMI patients and their families were hesitant to call emergency telephone numbers or did not understand the urgency of calling when heart attack symptoms happen.

At the other end of the STEMI continuum of care (at the time of hospital discharge), we also included interventions to help prevent future STEMIs by providing medications for patients to manage their underlying cardiovascular disease better.

Future programs should consider other ways to broaden impacts by combining programs for STEMI and other acute diseases, such as stroke, that have similar time-sensitive treatments. Integrating programs across chronic and acute cardiovascular disease care is another approach to consider.

***Large amounts of time and resources are needed to change medical treatment systems.*** We were not able to achieve as much improvement in the medical system quality improvement measures as we had hoped. Additional types of interventions should be tested in future programs, and ways to gain more intensive commitments from clinical staff should be identified. There are several possible approaches, including designing quality improvement programs with more frequent data feedback, stronger positive or negative financial incentives for hospitals, EMS agencies, and busy clinical care providers who sometimes work multiple jobs to provide for their families, additional types of recognition for hospitals and providers, and additional training and certificate programs.



*HeartRescue China training for EMS dispatchers*

## E. The Future

Each country identified strategies for sustaining its HeartRescue program and expanding to other cities. In India, this included working with local and state government agencies and a private foundation established for HRI. In China, it meant merging HRC into the national Chest Pain Centers program run by the China Heart House, which includes over 2,000 hospitals across China. In Brazil, HRB ensured sustainability by forming partnerships with local government agencies and schools, public and private hospitals, and a pharmaceutical company.

# Section 1. Overview of HeartRescue

## Global

### A. Background and Goals

The goals of the HeartRescue Global (HRG) project were to improve access and quality of care for patients with severe heart attacks, known as STEMs. Timely treatment of STEMI with reperfusion, including thrombolytic medications or percutaneous coronary intervention (PCI), is associated with improved patient survival, reduced disability, and reduced costs of care. HRG was implemented in three middle-income countries: India, China, and Brazil.

HRG was conceptualized by the Medtronic Foundation following 5 years of success with the HeartRescue US program. HeartRescue US focused on reducing mortality caused by cardiac arrest, started in five states, and now, at the time of this report, has expanded to 17 states. However, we realized early on that community knowledge and behaviors, EMS systems, and hospital infrastructures in the three HRG middle-income countries were not yet ready to tackle the problem of cardiac arrest, which requires a very short response time of 10 minutes or less. STEMI has a longer response time required of about 3 hours, and this was more realistic for the HRG middle-income countries that had many fewer economic and health care system resources per capita than the United States or other high-income countries.

The HRG focus on STEMI reflected the widespread problem that most middle-income countries lack the systems of care needed to provide effective STEMI treatment while facing ever-increasing burdens of cardiovascular disease in their populations. HRG was designed to respond to these gaps in STEMI systems of care and mitigate the effects of cardiovascular diseases on underserved populations. Prior to HRG, STEMI systems of care were mainly implemented in high-income countries such as the United States, which have much higher per capita gross national income.

**Per Capita Gross National Income in 2019 in the HRG Middle-Income Countries Compared with the US**

- India      \$2,130
- China     \$10,410
- Brazil    \$9,130
- US       \$65,292

Source: World Bank

HRG was based on the Diffusion of Innovations (DOI) theory of change, where individual cities were identified for the initial interventions in each of the three countries, to serve as

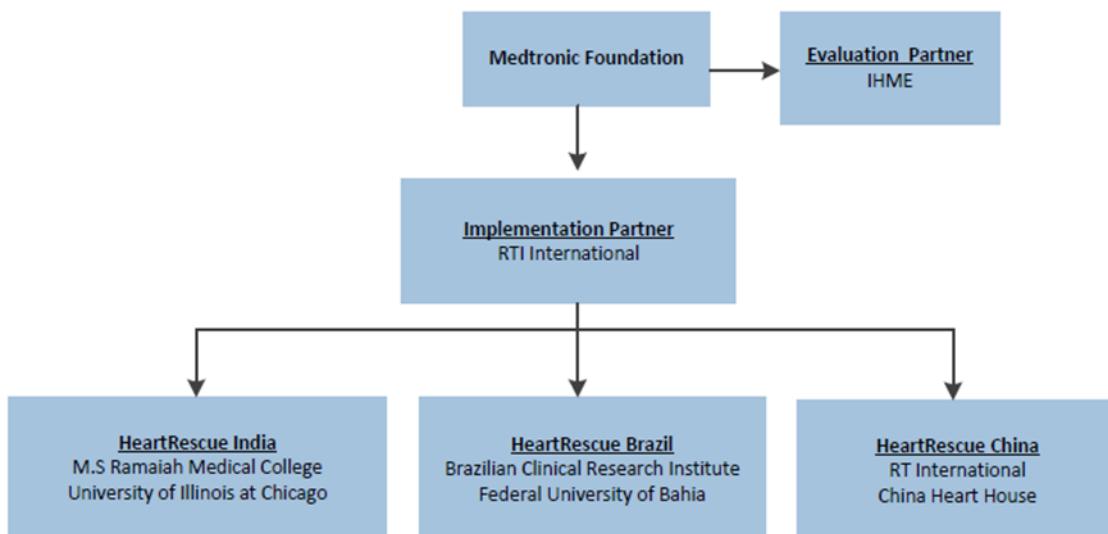
early adopters of innovations in systems of care for STEMI treatment. The cities included Bangalore, India; Suzhou, China; and VDC, Brazil. These early adopter cities then demonstrated to other cities in their countries that improvements in systems of care for STEMI patients are possible and thus motivated other efforts for diffusion and development of STEMI systems of care to other cities across each country.

To pursue this DOI effort, each HRG country program developed plans for sustaining and scaling up the HRG systems of care to other cities in their countries. In India, this included working with local and state government agencies and a private foundation established for HRI. In China, this included merging HRC into the national Chest Pain Centers program run by the China Heart House, which includes over 2,000 hospitals across China. In Brazil, this included partnerships with local government agencies and schools, public and private hospitals, and a pharmaceutical company. These plans are described in more detail in the following sections.

## B. Project Partners

RTI International was the Medtronic Foundation's implementation partner. RTI provided supervision and technical assistance for the three country programs in India, China, and Brazil. The IHME conducted an independent analysis of the project. The HRG organization chart in *Figure 1* shows the lead project partners in each country.

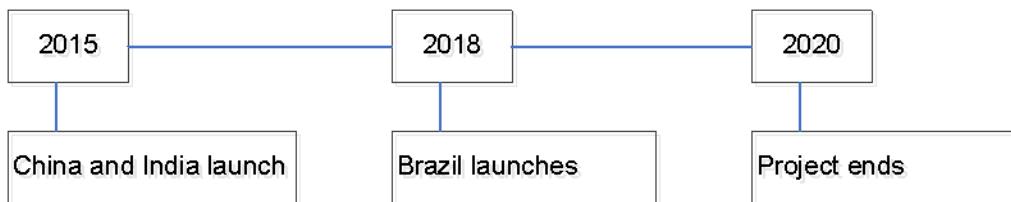
**Figure 1. HeartRescue Global Project Organization Chart**



The HRG project was operational from 2015 to 2020, although Brazil began its program in 2018. Each of the programs was interrupted in 2020 by the COVID-19 pandemic, which meant that health systems in each of the HRG countries were diverted to focus on

COVID-19 response. Patients suffering from STEMIs and other diseases were more hesitant to seek care due to fears of getting COVID-19 in the ambulances or hospitals. The HRG programs were able to operate for several months in early 2020 but were then put mostly on hold for interventions and data collection and feedback while the COVID-19 response took precedence. The overall timeline for HRG is shown in **Figure 2**.

**Figure 2. Timeline for HeartRescue Global**



*The HRG leadership team from the Medtronic Foundation, RTI International, Ramaiah Medical College, University of Illinois at Chicago, China Heart House, and the Brazilian Clinical Research Institute at the HRG project meeting in Bangalore in 2019*

## C. Interventions

Each of the country programs included interventions in three settings of care: (1) community, (2) pre-hospital EMS, and (3) hospitals. These three settings were chosen to address problems in the STEMI systems of care and eliminate barriers to care from the onset of heart attack symptoms, at home or in the community, through EMS response, and then through treatment in hospitals. Examples of the interventions are included below, and further details are included in the following sections that are focused on each country.

**Community interventions** raised knowledge and awareness of heart attack symptoms and the need to adopt new behaviors to act quickly to call emergency telephone numbers to get medical care when those symptoms happen.

**The problems:** In all three countries, patients and their families lacked knowledge about heart attack symptoms and were often hesitant to act to call emergency telephone numbers when those symptoms happened. Lack of knowledge about the available heart attack systems of care and fears of the potentially high cost of EMS and hospital care were also barriers to the rapid response needed for STEMI treatment to be effective.

#### HRG responses

- HRI held community health education events and set up help desks in hospitals to disseminate information to people visiting the hospitals and their families. HRI also developed a school education program for students and their families.
- HRC developed social media campaigns through WeChat, TikTok videos, television, and a website. HRC also worked with the local Suzhou public health agency on community health education events and organizing talks by community health center doctors.
- HRB worked with the local government's community health workers who were highly experienced in providing community education. HRB also developed a school education program with the local government high school system in partnership with the local governmental EMS agency, SAMU 192.

#### HRG results

- Increased numbers of patients arriving at the hospital by ambulance, instead of by walk-in (India). Prior to HRG, most patients were hesitant to call EMS, which often led to delays

#### Key Community Lessons Learned

- Working with schools was a good way to generate interest and enthusiasm for HRG
- We were not able to improve the other community setting quality indicators, such as reducing the time from symptom onset to first medical system contact, as much as we had hoped
- Future programs should study the community setting barriers in more detail to improve their interventions.

in STEMI treatment, which is a matter of life and death. The amount of heart muscle lost from lack of blood supply with STEMI is directly related to the length of time from symptom onset to definitive treatment.

- Increased numbers of calls to the SAMU 192 emergency telephone number (Brazil). This indicated increased knowledge and willingness to act by patients and their families because of HRB interventions.

**Pre-hospital EMS Interventions** for better quality and faster EMS responses included training on STEMI clinical guidelines and ways to speed EMS care

**The problems:** All three countries faced challenges in developing an effective EMS system, including staff well-trained in STEMI clinical guidelines. Effective EMS response includes early activation and dispatch of a first responder, conducting a rapid patient assessment upon arrival at the scene, initiating treatment under medical supervision, and transporting patients with STEMI or suspected STEMI rapidly to hospitals with reperfusion treatment capacity.

#### **HRG responses**

- HRI developed a new nurse-paramedic motor scooter ambulance system, HRG emergency telephone number, and EMS dispatch center. HRI also developed STEMI clinical guidelines and conducted training for the traditional ambulances based at HRG participating hospitals.
- HRC worked closely with the local government's Suzhou EMS system to develop and implement clinical guidelines for STEMI care, train EMS dispatchers to work better with calls from patients and family members, and improve data collection for the HRG patient registry.
- HRB worked with the governmental SAMU 192 EMS system to provide clinical guidelines and training for STEMI care, restart a "Motolance" motorcycle ambulance system, and engage SAMU 192 staff to collaborate on developing and implementing the school training program.

#### **HRG results**

- Improved the percent of STEMI patients with their time from first medical system contact to reperfusion of < 90 minutes (China).

#### **Key EMS Lessons Learned**

- Implementing a new EMS system, or improving existing systems, takes more time and resources than expected
- We were not able to improve other pre-hospital EMS quality measures as much as we had hoped

**Hospital interventions** included training in STEMI clinical guidelines to improve quality and new ways to speed hospital care for more effective treatment

**The problems:** In all three countries, hospital staff had limited knowledge of STEMI clinical guidelines and patient flows among hospital staff, a need for training among clinical staff for STEMI treatment protocols, and a lack of data availability and feedback to assess the current situation and track progress.

### The HRG responses

- HRI developed a “Hub and Spoke” STEMI referral and treatment system, including two referral Hub hospitals and five smaller community Spoke hospitals to enable patients to be assessed in their local hospitals and more quickly transferred for reperfusion treatment for STEMI when needed. The India team developed and implemented clinical guidelines for these HRG hospitals, trained staff in data collection for the STEMI patient registry, and provided training to Spoke hospital doctors on providing thrombolytic therapy that are one of the evidence-based STEMI treatment options for reperfusion.
- HRC partnered with five large tertiary hospitals and one secondary hospital in Suzhou. The China team developed and implemented clinical guidelines for STEMI care in both the EDs and in the cardiology units at those hospitals. They provided training in data collection to hospital staff, hired data coordinators at each hospital, and provided feedback to the clinical staff on the STEMI quality measure data from the HRC patient registry.
- HRB developed partnerships with the main government hospital in VDC and with three private hospitals. The Brazil team worked with those hospitals to expand access from part-time to 24/7 for PCI, which is the preferred option for reperfusion treatment for STEMI. The Brazil team developed and implemented clinical guidelines for STEMI treatment for the hospitals and worked with them to improve data collection for the STEMI patient registry.

### HRG results

- Increased the percent of STEMI patients receiving reperfusion, the evidence-based treatment for STEMI (India).
- Increased the percent of STEMI patients receiving medications at discharge for secondary prevention of cardiovascular disease, including statins and aspirin (India).

### Key Hospital Lessons Learned

- Time to treatment quality measures were harder to improve than access measure
- Training hospital staff caused turnover because many used their new skills to get higher paying jobs at other hospitals
- Future programs should plan for more intensive interventions in hospitals to improve the time to treatment indicators

## D. Quality Improvement Data Systems

**The problems:** All three countries lacked data for assessing the current situation regarding STEMI access and quality of care and lacked data feedback to hospitals and clinical providers over time to track progress and support quality improvement programs.

### HRG responses

Each of the country programs developed STEMI patient registries to collect data on a range of quality measures covering pre-hospital, in-hospital, and hospital discharge treatment. The registries also included patient demographic, health insurance status, and other factors to identify disparities in treatment for underserved groups. The quality measures enabled the country teams to assess the effectiveness of their interventions, track progress over time, and identify areas for improvement. IHME developed an online data visualization tool to collect and display the data for the quality measures for easier review, tracking trends over time, analyzing disparities for underserved groups, and providing feedback to clinical staff.

### HRG results

- Documented gender disparities by showing fewer women received STEMI treatment than men in the HRG patient registries. Women represented only 16% of the STEMI patients in the HRC patient registry and only 22% of the STEMI patients in the HRI patient registry.

### Key Data System Lessons Learned

- Data systems enabled documentation of the need for improved access for women for STEMI treatment
- Data collection and data quality problems were larger than expected. Future programs will need to plan more resources and training for the quality improvement data systems

- Implemented STEMI patient registries and tracked data on treatment of 2,037 STEMI patients across the three countries.



*The HeartRescue India team with Community Awareness Training participants*

## Section 2. HeartRescue India

### A. Background and Partners

To improve access and quality of care for STEMI patients in Bangalore, HRI included interventions across the three settings of care: (1) communities, (2) pre-hospital EMS, and (3) hospitals. Its catchment area included a 10-kilometer radius centered around the Ramaiah Medical College (RMC), the lead implementation site under the leadership of Dr. Aruna C. Ramesh. The HRI team also included the University of Illinois at Chicago (UIC) led by Dr. Terry Vanden Hoek, and many local partners in Bangalore (see

#### **Appendix 1.**

HRI implemented data systems to monitor the impact of interventions on the STEMI system of care. HRI also developed a strong curriculum of community and school-based education to raise knowledge and awareness of STEMI symptoms.

Additionally, HRI included two innovations in EMS and hospital care:

#### **HRI's Catchment Area Included 400,000 people. Underserved Populations Included**

- 34% with middle school education or less
- 44% with income less than 33,000 Rs annually
- 78% with no health insurance

Source: IHME Household Survey

1. An HRI nurse-paramedic motor scooter EMS system, with an emergency telephone number and dispatch center, a new infrastructure to facilitate faster pre-hospital EMS response to people with symptoms of STEMI.
2. A Hub and Spoke referral and treatment system among hospitals, creating partnerships to facilitate access to reperfusion, the evidence-based treatment for STEMI patients. Under this system, five sub-specialty Spoke hospitals increased their capacity to deliver thrombolytic medications before transferring patients, if needed, to one of the two Hub hospitals with cardiac catheterization laboratories.

HRI began in 2015 and ended in 2020. During the early years, the HRI team continued to gather information about the local community context and planned the timing and types of interventions to be conducted. The Indian Council of Medical Research, the topmost regulatory body for medical research in India, approved the project's data management process after a rigorous evaluation.

For Years 3 to 5, seven task forces were organized with RMC, UIC, and RTI staff to implement the key elements of HRI. Each task force was chaired by an RMC staff member. They included (1) Community Health Services, Dr. Aruna C. Ramesh; (2) Pre-Hospital Services, Dr. Harish K S; (3) Dispatch and Heart Code Services, Dr. Keshava Murthy M R; (4) Cardiology Services, Dr. Anupama V Hegde; (5) Data & Analysis, Mr. Shivaraj N S; (6) School Services, Dr. Hariprasad K V; and (7) Research & Publications, Dr. Aruna C. Ramesh.

## B. Data Systems for Quality Improvement

HRI's data system for quality improvement was based on the *problem* of lack of data for assessing the current situation regarding STEMI access and quality of care and lack of feedback over time to guide improvements in care processes and track progress. As a result, the HRI data system *interventions* included a STEMI patient registry, quality measures, and non-registry data on HRI program processes.

As the project's evaluation partner, IHME developed an online data visualization tool to track performance over time and enable feedback to providers on progress and to identify problem areas. HRI staff trained the Hub and Spoke hospitals on improved procedures for collecting accurate, complete data at the time of patient care, why data

### Data Systems Activities

- 1,010 STEMI patients tracked in the HRI patient registry
- 654 hospital staff trained in data collection
- Documented gender disparities in access by showing that women represented only 22% of the STEMI patients in the patient registry

collection is important, and how to use the data to improve care. HRI quality assessment and improvement were based on a set of 26 quality measures, including 10 pre-hospital measures, 10 in-hospital measures, and six hospital discharge measures. They are listed in *Appendix 2*.

A challenge for this HRI quality improvement data system was turnover of staff trained in data capture at the smaller Spoke hospitals. The Spoke hospitals were private and had limited financial resources; HRI-trained staff were more marketable and often moved to other jobs offering higher pay. This resulted in an ongoing cycle of training staff, staff

leaving for other jobs, recruiting new staff, and then training the new staff. To address these issues, HRI developed new sources for recruiting replacement staff and stationed an HRI staff member at each of the Spoke hospitals to educate staff, monitor operations, and collect data on HRI patients.

The HRI STEMI patient registry also enabled HRI to document gender disparities in access to STEMI treatment. The number of women in the HRI patient registry was much lower than the number of men across all age groups. Of the overall 1,010 STEMI patients in the HRI patient registry, 78% were men and only 22% were women. However, we found that once women gained access to the HRI system of care, the quality measures show that their care is similar to the care provided to men. This highlights the need for future work to address gender disparities in the community and to develop a better understanding of the barriers limiting female access to the HRI level of STEMI care.

## C. Community Interventions, Results, and Lessons Learned

### I. Interventions

Community interventions focused on the **problems** of lack of knowledge about heart attack symptoms, lack of understanding of the need to call for medical help quickly when those

symptoms happen, and delays of patients and families in seeking medical care because of socioeconomic and cultural barriers. A needs assessment included analysis of the socioeconomic status of each of the communities in the HRI catchment area and identification of access-related barriers, service delivery gaps, and community issues and opportunities. As a result, the HRI community **interventions** focused on increasing knowledge and recognition of heart attack symptoms, how to access the HRI Hub and Spoke hospital system of care, including the HRI toll-free emergency telephone number, and the importance of calling for help quickly at the onset of heart attack symptoms.

HRI reached the community through educational events, a schools program for 8th and 9th graders, and hospital-based help desks that offered education and cardiovascular disease (CVD) risk screenings for patients, patient attenders, family, and friends.

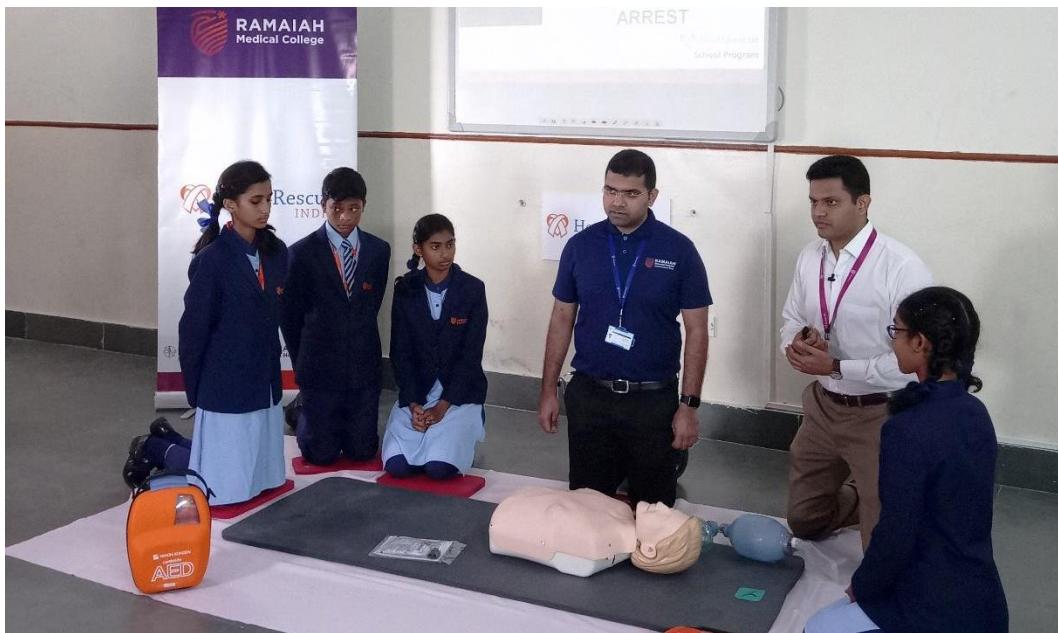
**Community education events.** The HRI Community Health Services Task Force developed and implemented communication strategies with messages about the recognition of heart attack symptoms, awareness of the HRI toll-free emergency

#### Community Setting Activities

- 1,230 people screened for CVD risk at community education sessions
- 1,820 school children educated in school-based curriculum
- 4,444 people screened for CVD risk in HRI hospitals and clinics

telephone number and the importance of calling this toll-free number for help when chest pain or heart attack symptoms happen. Those messages were featured in brochures and a video. HRI also disseminated information and materials to Civil Defense volunteers, community workers, and hospital staff.

**Schools program.** Ten local schools participated with HRI staff for education of 8th and 9th grade students and their families about heart attack symptoms and how to respond quickly when the symptoms happen to anyone in their families or communities, because students can play an important role in promoting health behavior changes in the community. The students were actively engaged in the innovative teaching methods and were geared to involve their parents and other family members at each step. Through homework, the students educated family and community members about heart attack symptoms, the need for family action planning, and opportunities for family and community members to attend HRI community education and health screening events. The students also made follow-up calls to at-risk individuals (particularly family and community members they knew) to ensure that high-risk individuals were informed about the HRI Hub and Spoke system of care and how to access it in the event of heart attack symptoms.



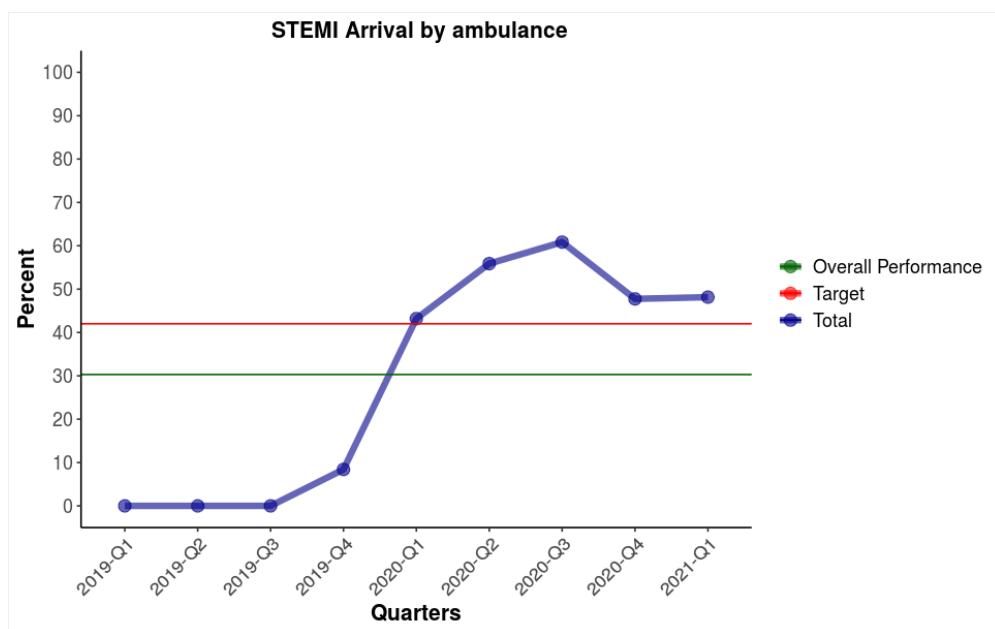
*The HeartRescue India schools training program*

**Hospital-based help desks.** Each of the seven hospitals in the Hub and Spoke system set up help desks to screen walk-in patients and visitors for CVD risk factors, create awareness of the HRI toll-free number and the importance of calling when chest pain or heart attack symptoms happen, and talk with community members about the HRI app that could connect them to the nurse-paramedic motor scooter first responder system.

## II. Results

HRI tracked quality improvement over time using graphs included in IHME's online data visualization tool. The percentage of patients who arrived at an HRI hospital by ambulance instead of by walk-in improved during HRI (see **Figure 3**). Ambulance is the preferred method of hospital arrival for STEMI patients because early EMS contact provides for more rapid assessment of patient symptoms, more rapid electrocardiogram (ECG) testing, and more rapid transport to hospitals for STEMIs and suspected STEMIs to receive the time-sensitive reperfusion treatment as soon as possible. This graph indicates that more STEMI patients began calling for EMS services because of the HRI interventions, exceeding the target performance level, which was set as an achievable goal given average performance over time.

**Figure 3. Percent of STEMI Patients Arriving at an HRI Hospital by Ambulance**



Source: IHME Analysis of HeartRescue India Patient Registry Data

### III. Lessons Learned

**Working with local schools and their 8th and 9th grade students was a good way to generate interest and enthusiasm for HRI.** Students were eager to absorb the information about CVD, heart attack symptoms, and how to respond quickly when heart attack symptoms happen. They enjoyed sharing those lessons with their parents and other family members in homework assignments. Support from school principals and teachers was critical for the success of the HRI education modules. This novel hospital/school collaboration can also serve as a platform for myriad other public health interventions.

**Fears of catastrophic medical expenses were a continuing barrier to seeking care at HRI.** HRI conducted community education about government health insurance programs, about the free cost of HRI EMS care, and about options to transfer to government hospitals if requested, but they were less effective than we had hoped. There remain widespread fears in the community about the high cost of care from private ambulances and hospitals such as those in the HRI system. Government health insurance schemes also need to be more broadly implemented for STEMI and other acute CVD events in private hospitals so that patients can be convinced that they can receive affordable care from private hospitals. People still trusted government hospitals more to provide them with affordable care in Bangalore.

## D. Pre-hospital EMS Interventions, Results, and Lessons Learned

### I. Interventions

The pre-hospital EMS interventions focused on the **problems** of implementing an effective EMS system, including early activation and dispatch of a first responder, conducting a rapid patient assessment upon arrival at the scene, and initiating treatment under medical supervision to prevent a poor outcome. An additional challenge in Bangalore is the heavy city traffic that frequently delays traditional ambulances. As a result, the HRI **interventions** included an innovative nurse-paramedic motor scooter first responder system with a dedicated HRI toll-free telephone number and dispatch center to process emergency calls when a caller reported that someone has heart attack symptoms.

#### EMS Activities

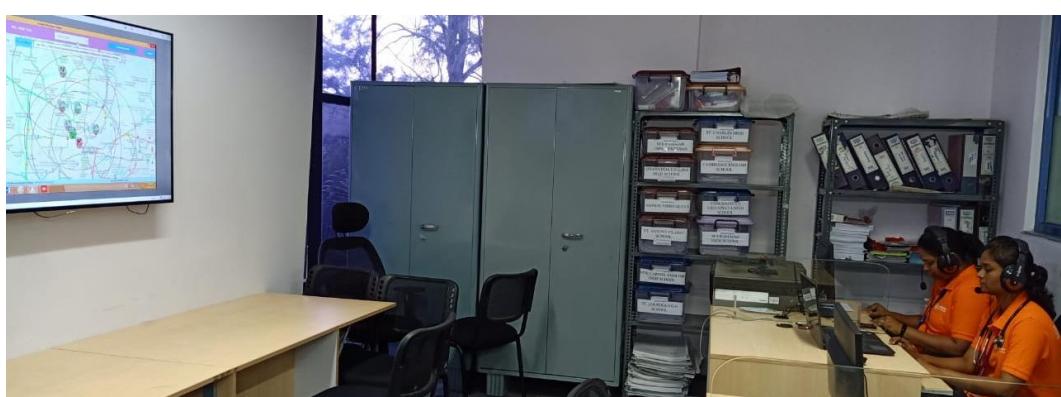
- 47 EMS dispatchers trained
- 588 EMS first responder motor scooter drivers trained

HRI implemented the nurse-paramedic motor scooter first responder system starting in 2019 after receiving appropriate ethical and regulatory approvals. To prepare, team members procured equipment and trained on clinical, data, and driving components. First, the clinical components included how to effectively treat patients upon arrival at the scene in the community, including ECG basics, recording and live transfer of ECG results, Basic Life Support (BLS), first aid of common medical emergencies, communication with patients and families, and first responder roles and responsibilities. Second, HRI resolved pre-hospital data transmission and connectivity issues between the field sites where the nurse-paramedics treated patients upon arrival at the scenes and the data collection systems at the hospitals. Third, HRI recruited and trained the nurse-paramedics to maneuver motor scooters safely through the intense Bangalore traffic and in vehicle maintenance.

A series of mock emergency runs using the motor scooters were conducted to test and refine this new system before it was deployed.

#### New HRI Pre-hospital EMS Protocols

- ECGs
- Informed consent from patient
- Response to patient refusal of treatment
- First responder clinical procedures
- Activating the STEMI Hub and Spoke hospitals' response with their ambulances
- HRI emergency call center dispatch procedures
- Data capture procedures
- Using the call center software
- Data transmission from the field to the hospitals
- Checking and improving data quality

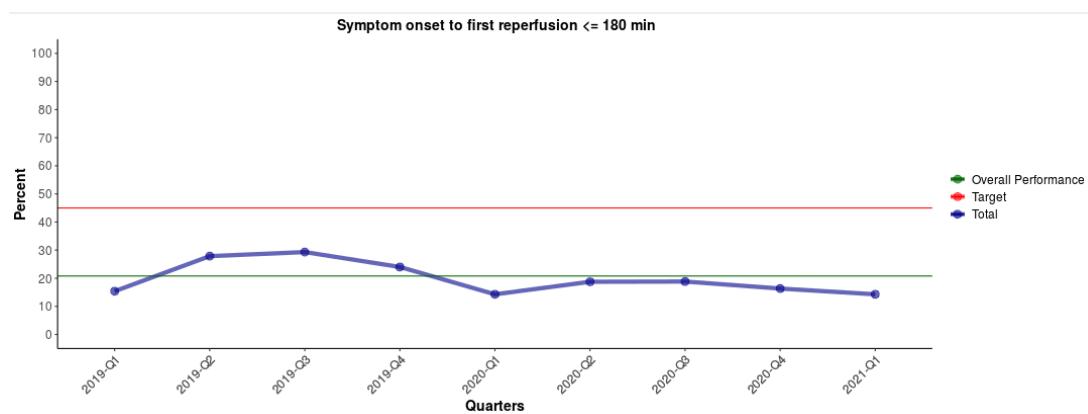


*The HeartRescue India pre-hospital EMS dispatch center*

## II. Results

**Figure 4** shows the results for the global HRI quality measure covering the community, EMS, and hospital settings of care. It is included here as the main HRI quality measure that included the EMS setting. **Figure 4** shows that the percent of STEMI patients with their overall time to treatment  $\leq$  180 minutes across the three settings of care did not increase during HRI, which was disappointing. Different types of interventions or more intensive interventions in these settings may be needed to improve these overall time to treatment results in other programs.

**Figure 4. Percent of STEMI Patients with Time from Symptom Onset to First Reperfusion  $\leq$  180 Minutes**



Source: IHME Analysis of HeartRescue India Patient Registry Data

## III. Lessons Learned

### **Local challenges can delay progress, so start regulatory processes early.**

Local authorities required lengthy ethical and regulatory approvals, such as the special approvals needed from the Bangalore Road Transportation Authority to deploy the motorcycle ambulances. Engineers were needed to successfully convert a regular motor scooter into a motor scooter ambulance with the required added safety features.

**Setting up an innovative HRI nurse-paramedic motorcycle first responder system requires extensive training and field testing.** Recruiting, training, and motivating the first responders were ongoing challenges. Nurse-paramedics received 2 weeks of safe motor scooter riding training and completed multiple dry run tests of the first responder procedures and equipment. Before and after deployment, equipment and network connectivity troubleshooting was required to ensure that data collected in the field (i.e., patient condition and ECG results) would reliably transmit to the HRI hospitals. Emergency dispatch capabilities also required enhancement, including pre-arrival notifications for the HRI hospitals when patients were on their way to them.



*HeartRescue India nurse-paramedic motor scooter ambulance first responders at their training*

## E. Hospital Interventions, Results, and Lessons Learned

### I. Interventions

The HRI hospital interventions focused on the initial **problems** of limited knowledge of STEMI clinical guidelines and efficient patient flows among hospital staff, a need for training among clinical staff on STEMI treatment protocols, and lack of data availability and feedback to assess the current situation and track progress. As a result, HRI hospital **interventions** began with a review of the STEMI patient flows and clinical protocols at each step of the treatment process to reduce the time to treatment. This included pre-hospital care, hospital emergency department (ED) treatment, reperfusion with PCI in a cardiac catheterization laboratory when possible or reperfusion with thrombolytic medications, hospital ward care, and post-discharge care.

#### Hospital Setting Activities

- 263 doctors trained
- 1,631 nurses, paramedics, and non-clinical staff trained

HRI staff from MSRMC conducted multiple site visits to each Hub and Spoke hospital to review the clinical protocols, data collection and reporting challenges, and identify strategies for improvement. Ongoing recruitment and training of new hospital staff was needed because of high levels of staff turnover. HRI staff developed improvements in clinical protocols, such as how to address delays caused by lengthy consent procedures with families and how to reduce the discomfort of non-emergency-trained doctors with administering thrombolytic medications for STEMI patients.

A key partnership for the HRI hospitals was with the Sri Jayadeva Institute of Cardiovascular Sciences and Research Hospital in Bangalore, a government hospital, and the largest cardiac care hospital in India. This benefitted HRI's reputation because Jayadeva has a strong reputation in Bangalore for high-quality care. Some HRI patients without health insurance opted for a transfer to Jayadeva, and their staff agreed to share data on HRI patients who were transferred.

#### New HRI Hospital Protocols and Training

- STEMI clinical guidelines
- Order sets
- BLS
- Advanced cardiac life support (ACLS)
- Signs and symptoms of heart attack
- ECG operations
- Pharmacology
- Cardiac catheterization lab operations
- Checking and improving data quality



*HeartRescue India training for hospital staff*

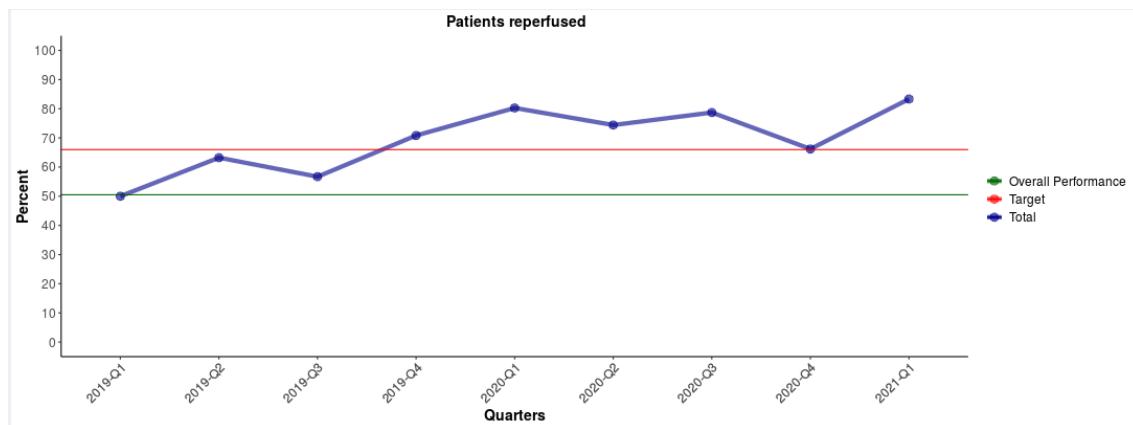
## II. Results

A hospital setting access measure that improved over time during HRI was the percent of all STEMI patients who received reperfusion (either by PCI or thrombolytic medications), as shown in **Figure 5**. This graph indicates that the HRI Hub and Spoke hospitals were able to increase the percentage of STEMI patients not transferred to other hospitals who received reperfusion during HRI because of the clinical guidelines and other HRI hospital interventions.

A hospital discharge HRI preventive care quality measure that showed substantial improvement over time was the percent of all STEMI patients who were discharged with

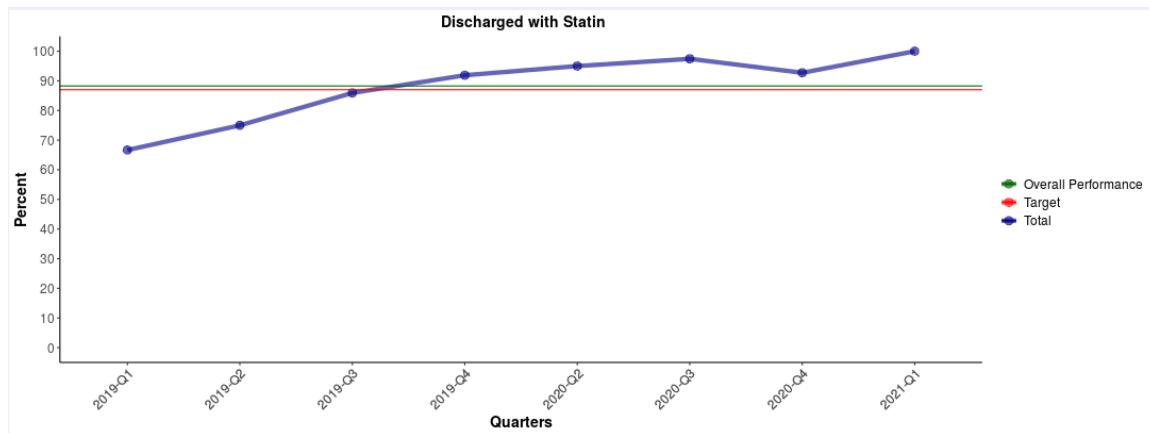
statin medications, as shown in **Figure 6**. This graph indicates that the HRI Hub and Spoke hospitals were able to increase the percentage of STEMI patients who were discharged with statins because of the clinical guidelines and other HRI hospital interventions. Additional results for other hospital quality measures are included in **Appendix 3**.

**Figure 5. Percent of STEMI Patients Not Transferred to Other Hospitals Who Received Reperfusion**



Source: IHME Analysis of HeartRescue India Patient Registry Data

**Figure 6. Percent of STEMI Patients Discharged with Statin Medications**



Source: IHME Analysis of HeartRescue India Patient Registry Data

### III. Lessons Learned

**Physician hesitation to administer thrombolytic medications was a barrier to timely administration of thrombolytics for STEMI patients in some HRI hospitals.** Thrombolytics are one type of reperfusion therapy for STEMI to reduce heart

damage and save lives. Rapid treatment with thrombolytics at Spoke hospitals is usually indicated before referring and transferring a STEMI patient to a Hub hospital, because the time involved in transfer can result in additional heart muscle damage or patient death. Non-emergency-trained physicians were concerned about the side effects and contraindications for the thrombolytic medications they were not familiar with and the potential for lawsuits from patients or their family members if the patient had an adverse outcome or died despite the best efforts of the physicians to treat the STEMI patient. To address this critical issue, HRI worked with Jayadeva Hospital to create a thrombolytics training certificate program for physicians to instill confidence for prescribing thrombolytics while also offering some legal protection.

***Confidently identifying STEMI cases based on ECG output was a challenge for some clinical staff at the HRI hospitals.*** HRI addressed this problem by training physicians at the HRI hospitals to read and interpret ECGs and creating a plan to double-check each ECG for proper identification of STEMIs.

***There were challenges in maintaining active involvement of the smaller, private Spoke hospitals.*** Some Spoke hospitals did not initially see the value in participating in the HRI Hub and Spoke system of care. It took some time for them to become familiar with HRI, its training methods, attention to details in STEMI care, and standard operating procedures to better understand the value of HRI. They also saw the reputational value from HRI for them in their communities as a benefit for attracting patients to their hospitals. Nonetheless, these smaller and private hospitals needed personnel support from HRI for data entry, recruiting and training new staff, and communications about the HRI program in their communities. HRI senior staff from MSRMC visited the Spoke hospitals frequently to better understand the challenges they were facing and worked with them to find solutions. In the future, appropriate incentives will be needed for the Spoke hospitals to expand their participation in HRI data collection and to provide more HRI services for indigent patients.

## F. Sustainability and Future Plans for Scaling Up in India

### I. Sustainability

To promote sustainability, HRI established the non-profit Svasth-Heart India Foundation, which was approved by Government of India in February 2019. This foundation allows HRI to accept corporate donations lawfully. It will open the door for private donors to continue funding the program and facilitate its expansion throughout the state of Karnataka. Stakeholder engagement was another key effort for HRI sustainability. This

included building relationships with a wide range of non-profit and governmental organizations listed in **Appendix 4**. Building visibility and reputation was another strategy for sustainability. To pursue this goal, the HRI team published four papers in scientific journals and conducted 20 conference presentations to highlight and disseminate their work. They are listed in **Appendix 5**.

## II. Scaling Up

The HRI team continues to work diligently to make the HRI Hub and Spoke model of STEMI care a scalable program that can be replicated in full or in components based on the individual needs of other communities, cities, and states across India. We have already seen some new programs resulting from HRI across India. Some cities (e.g., New Delhi, Goa, Telangana, Mysore, and Udaipur) have reviewed the HRI system and implemented strategies like HRI. Others have reached out to HRI to ask our team to be a partner, advisor, or consultant in the development of similar programs. These include the State of Telengana, Mission Delhi of the All India Institutes of Medical Sciences, and a chain of five hospitals in Mumbai. Our aim is to have a proven and lasting STEMI system of care spread to many other states and cities that will provide effective and affordable access to high-quality care for the people of India.

HRI will continue to engage with multiple government and private sector stakeholders to co-design processes that build on our HRI program to develop solutions that can be tailored to different contexts across India. We will work toward filling gaps in health care infrastructure; training professionals and non-professionals to provide care to underserved populations; and sharing our educational and training programs, health systems, innovations, and technology solutions.

HRI also sees a future for public/private first responder EMS systems in India, including a potential collaboration between HRI and the government's 108 EMS system. The HRI team is reviewing options for EMS system structures, including hybrid public/private systems operating in other countries. We envision organizing a conference in which health care systems doing similar work across India will meet with key state and national government stakeholders to build momentum for coordinated expansion of public/private first responder EMS systems.



*A HeartRescue India community education event*



*HeartRescue China training for EMS staff*

## Section 3. HeartRescue China

### A. Background and Partners

HRC included interventions across the three settings of care: (1) communities, (2) pre-hospital EMS, and (3) hospitals to improve access and quality of care for STEMI patients in Suzhou. Its catchment area was centered around four large tertiary care hospitals and one secondary hospital that served different communities. HRC worked with the Suzhou city

**HRC's Catchment Area Included 2,000,000 People. Underserved Populations Included**

- 20% migrant workers
- 20% with less than 6 years of education
- 25% lacking adequate health insurance

Source: Suzhou Health Bureau

EMS system and started with a pilot hospital, the Suzhou Kowloon Hospital, led by its President Dr. Liu who was a cardiologist and key local champion for the HRC program. HRC was led by Dr. Zhi-Jie Zheng at RTI and the China Heart House (CHH), which is the operational arm of the China Cardiovascular Society based in Suzhou. HRC had a wide range of local partners (see **Appendix 6**).

In addition to developing a patient registry data system to track access and quality measures for STEMI care and a strong training curriculum for community, EMS, and hospital staff, HRC included several innovations:

1. Creating a public messaging campaign, with social media, TikTok videos, and television programs.

2. Convening a National Advisory Committee of senior experts from across China and an Implementation Local Group of Suzhou-based stakeholders, two bodies that engaged government and professional associations in programmatic and policy changes.
3. Advising the governments of Suzhou and Shanghai on developing local Good Samaritan regulations that protect bystanders legally when they help people suffering from heart attacks and other emergencies. This was recently passed as a Chinese national law in 2020.

HRC ran for 5 years, from 2015 to 2020. In Years 1 to 3, the HRC program focused on developing education and training programs for community outreach and clinical protocols, training, and data systems with the Suzhou city EMS system and the Suzhou Kowloon Hospital, and exploring the possibility of also implementing the program in other locations. By Years 4 and 5 HRC included interventions in eight areas: (1) project management and partnerships; (2) community and general population; (3) pre-hospital EMS; (4) EDs; (5) hospital departments for cardiology, cardiac critical care unit, and cardiac catheterization lab; (6) patient registry and data systems; (7) policy development and research; and (8) sustainability planning.

## B. Data Systems for Quality Improvement

HRC's data collection and reporting system included a STEMI patient registry and non-registry data on HRC care system development processes. CHH developed a central database that included HRC data collected from training, community events, EMS data, and patient registry data collected and transmitted from the participating hospitals. HRC staff reported data results each month to enable analysis, to develop the feedback reports for quality improvement meetings with the EMS agency and HRC hospitals, and to check and improve HRC data quality.

### Data Systems Activities

- 973 STEMI patients tracked in the HRC patient registry
- 405 hospital staff trained in data collection
- Documented gender disparity in STEMI treatment, showing that women were only 17% of STEMI patients in the patient registry

HRC used the same IHME online data visualization tool as HRI. Similarly, HRC used the same IHME data quality monitoring reports as HRI, to identify, track, and trouble-shoot missing data, out-of-range values, and other data quality issues. HRC quality of care assessment was based on a set of 24 quality measures, including 10 pre-hospital measures, 10 in-hospital measures, and four hospital discharge measures (see **Appendix 7**).

The patient registry also enabled HRC to document gender disparities in access to STEMI treatment. Our analysis showed that only 17% of the patients in the HRC registry were women and the number of women was much lower than the number of men across all age groups. However, analysis of the HRC quality measures also showed that once women gained access to the HRC system of care, their care was similar to men. This highlights the need for future work to address gender disparities in the community and the health care systems that are limiting women's access to STEMI care.

## C. Community Interventions, Results, and Lessons Learned

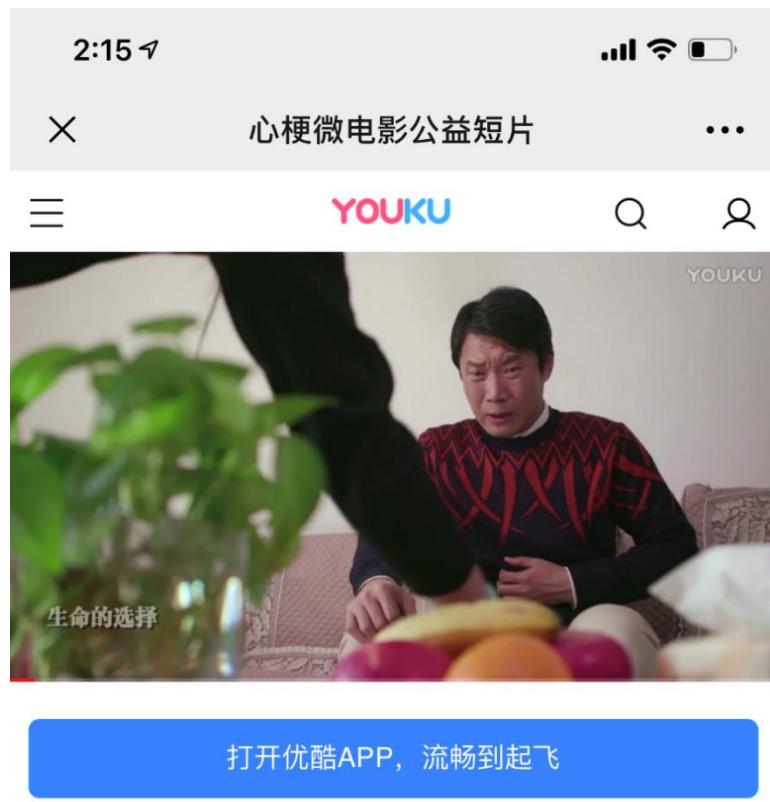
### I. Interventions

Although Suzhou had a good health care infrastructure compared with other cities in China, the system of care for treating STEMIs suffered from several **problems**. Community interventions focused on the lack of knowledge and awareness of heart attack symptoms, lack of understanding of the need to call for medical help quickly when those symptoms happen, and delays of patients and families in seeking medical care. The HRC community **interventions** included media-driven campaigns, educational events, and programs for underserved populations.

#### Community Setting Activities

- 71 community education events
- 2,267 community members trained in community education programs

**Social Media and TV Campaigns.** HRC created social media campaigns, including using WeChat, TikTok video sharing, and Weibo, to push targeted messages on prevention and management of heart attacks. The TikTok videos showed an average person what the signs and symptoms of heart attacks look like and the importance of calling the emergency telephone number 120 quickly when those symptoms happen. Some of these TikTok videos became very popular. The CHH sponsored periodic competitions for hospitals and physicians to submit 3- to 5-minute videos on how to creatively educate and engage patients on these HRC messages.



## 心梗微电影公益短片

简介 ▾

*A HeartRescue China short video on recognizing heart attack symptoms*

**Education and training events.** HRC staff led health education and training programs on heart disease, heart health, the signs and symptoms of heart attacks, and the need to call 120 quickly when heart attack symptoms occur. The health training programs were conducted in community centers in residential buildings, high schools and colleges, community health centers, and with community physicians who provided health education programs. HRC also hosted Suzhou's annual events for Heart Month in September each year. In partnership with the Suzhou government and hospitals, these events provided a range of public education programs.

The national and highly visible “1120” public education campaign emphasized the need to call the emergency telephone number 120 and to get to the hospital in 120 minutes or less when heart attack symptoms occur. The campaign is held each year on November 20, or 11/20. The goal is to provide a simple and memorable message to the public. News media were involved with both national and local television stations broadcasting programs with these messages. Furthermore, expanded programming with Channel 9, China’s national television health channel, featured programs on heart disease, heart

health, heart attack symptoms, and the need to call 120 when heart attack symptoms appear.



*HeartRescue China community awareness training during National Heart Attack Day on 11/20*

**Programs for Underserved Populations.** To reach underserved populations, HRC developed programs with several partners, including the Suzhou Health Bureau and the local Centers for Disease Control and Prevention (CDC), on health promotion, education, and communication targeted at these often hard to reach populations. For migrant workers, these included partnerships with the companies employing them to provide health clinics and supplemental insurance because they are only eligible for health insurance coverage through their cities of official residence and not in Suzhou. For people with little or no education, including those who may not use social media or read written health promotion materials, HRC partnered with community health workers to integrate HRC messages into their face-to-face meetings.

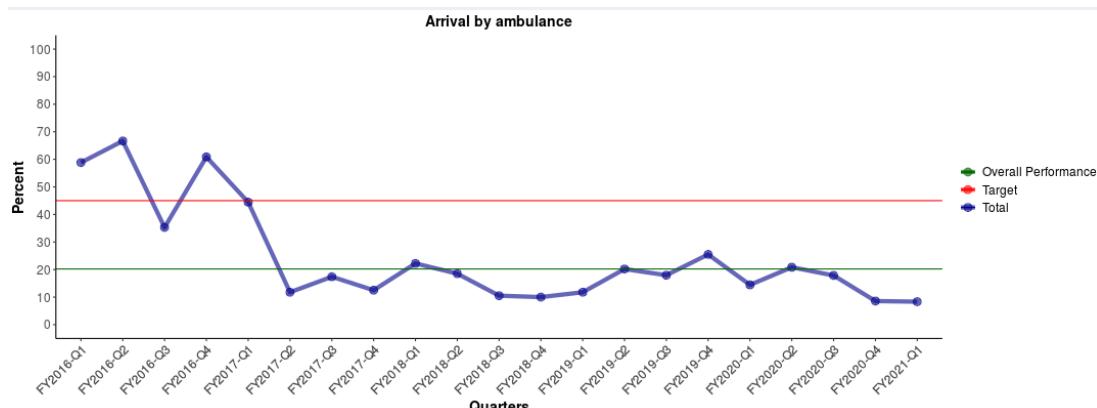
#### Community Interventions

- Short videos and programs for wide audiences
- Publishing and distributing booklets, pamphlets, and fact sheets
- Exhibits and check-in centers set up in buildings frequented by elderly residents
- Written, media, and face-to-face messaging

## II. Results

Despite the wide range of community interventions, the HRC community setting quality measures did not improve. **Figure 7** shows that the percentage of STEMI patients arriving by ambulance instead of by walk-in did not increase during HRC. Perhaps the type, intensity, or targeting of the public messages or events were not sufficient to generate lasting effects on patient behavior.

**Figure 7. Percent of STEMI Patients Arriving at a Hospital by Ambulance Instead of by Walk-In**



Source: IHME Analysis of HeartRescue China Patient Registry Data

### III. Lessons Learned

#### ***Alignment with the Suzhou government public health priorities was critical for HRC.***

Government support is important for all health care projects in China. Because HRC fit with the Suzhou Health Bureau's campaign to improve care for heart attacks, as one of five high-priority diseases for the city, HRC garnered support from champions in the government and participating health care providers in Suzhou.

#### ***Increasing community education was important but not sufficient for changing patient behavior.***

In early data analysis, HRC found that only 20% of STEMI patients were transported to hospital by ambulance. As a result, community education was expanded to address the widespread lack of knowledge of heart attack symptoms and the need to call the central emergency telephone number 120 as soon as those symptoms occurred. However, additional qualitative research is needed with patient and family focus groups and interviews to design more effective community education programs that will change patient behavior and increase utilization of ambulances to reduce the time to reperfusion treatment for STEMI patients.

## D. Pre-hospital EMS Interventions, Results, and Lessons Learned

### I. Interventions

The pre-hospital EMS interventions focused on the **problems** of improving the training of EMS staff on STEMI treatment protocols, including early diagnosis, reducing time to hospital arrival, and ensuring effective

#### **Pre-hospital EMS Activities**

- 275 EMS dispatchers trained
- 333 EMS ambulance drivers trained

coordination of care with hospital EDs. The HRC pre-hospital EMS *interventions* addressed those problems by training EMS dispatchers, revising and disseminating clinical protocols, collecting data, and using communications technologies.

**Training EMS Dispatchers.** HRC trained EMS call center dispatchers to improve their knowledge of heart attacks and indications of STEMI, how to respond to patients, and to develop their skills in communicating with callers. HRC then monitored and evaluated the calls conducted by the emergency call center staff at the Suzhou EMS to improve the quality of calls and revise training materials and methods.



*HeartRescue China training for EMS dispatchers*

The Laerdal Foundation, the China Cardiovascular Health Association and Chinese Society for Emergency Medical Responses, donated training equipment and staff time for helping developing training capacity. Laerdal and HRC also established the HRC Resuscitation Academy to provide high-quality cardiopulmonary resuscitation (CPR) training for EMS and ED staff and to train community residents on the signs, symptoms, risk factors, and management of heart disease and the importance of calling 120 quickly for heart attack symptoms.

**Disseminating Clinical Guidelines.** Prior to the HRC program, there were few clinical guidelines available for EMS doctors and staff. HRC expanded and disseminated clinical guidelines for EMS doctors and staff on treatment of STEMI and other acute CVD

events. HRC staff also conducted semi-annual training for EMS doctors and staff on the clinical guidelines, including identifying chest pain, heart attack, and STEMI and use of medications for treatment.

**Collecting Data.** HRC trained EMS doctors and staff on data collection and documenting data more completely in medical records, including semi-annual training for EMS doctors and staff on methods for quality improvement using data feedback. This training included interpreting data analyses to identify quality of care problems and opportunities for quality improvement. Training also demonstrated plan-do-study-act (PDSA) cycles, which use data to test the effectiveness of clinical procedures or intervention operations for further dissemination or for development of new interventions.

#### New HRC Pre-Hospital EMS Protocols

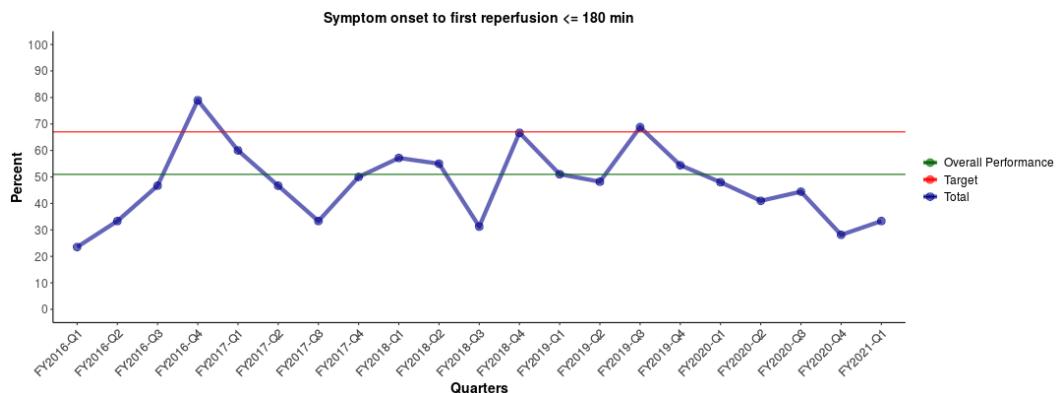
- HRC emergency call center dispatch procedures
- Dispatcher-guided CPR
- First responder clinical procedures
- Data collection procedures and PDSA cycles
- Checking and improving data quality
- Audio and video communications and data transmission from ambulances to the EDs
- Bar codes for recording the times of patient interactions and treatments

**Using Communications Technologies.** HRC advised the Suzhou EMS administration on the importance of effective communications and data collection technologies, including options for equipment placement, usage, and upgrades. Specifically, HRC recommended using video and audio communications links between the EMS ambulances and the hospital EDs, WiFi access for web communications, and the use of bar codes to record the time of each step of the patient's journey with the Suzhou EMS, from the initial call to the 120 emergency telephone number, to EMS arrival at the patient's location and pick-up, and to transport and arrival at the hospital ED.

## II. Results

HRC was able to improve some quality measures for pre-hospital EMS care but did not improve on the most ambitious: increasing the number of STEMI patients receiving recommended, time-sensitive reperfusion treatment in less than 180 minutes from onset of symptoms, a measure that reflects the performance of the entire system of care across community, EMS, and hospital settings. **Figure 8** shows that the percentage of patients with reperfusion treatment within the recommended time threshold did not increase during HRC. It may be that different or more intensive interventions are needed across the three settings of care.

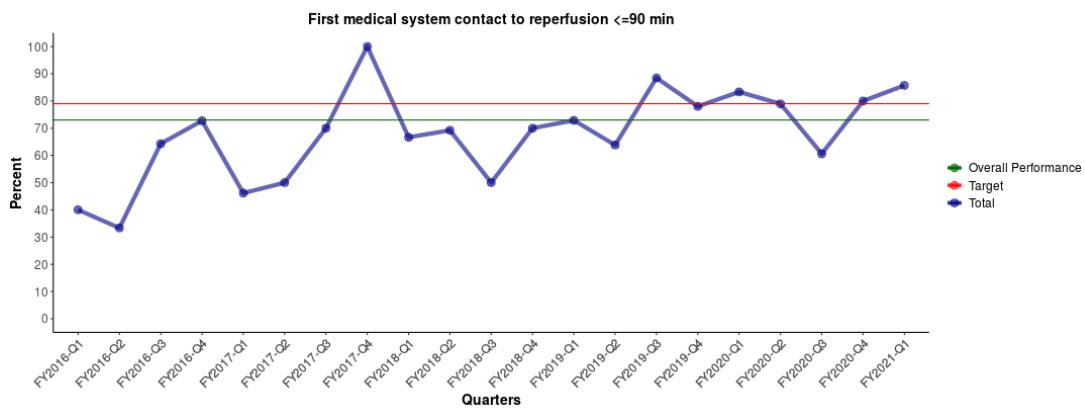
**Figure 8. Percent of STEMI Patients With Time from Symptom Onset to First Reperfusion ≤ 180 Minutes**



Source: IHME Analysis of HeartRescue China Patient Registry Data

In contrast, **Figure 9** illustrates the percentage of STEMI patients with time from first medical system contact to reperfusion of 90 minutes or less during the HRC program, a measure that more directly reflects care received in the pre-hospital EMS and hospital settings. This measure showed improvement over time, reflecting the effects of HRC interventions for improving STEMI care. Notably, this measure reached its target of 80 percent for most of the past 2 years.

**Figure 9. Percent of STEMI Patients with Time from First Medical System Contact to Reperfusion ≤ 90 Minutes**



Source: IHME Analysis of HeartRescue China Patient Registry Data

Fast ambulance response of 20 minutes or less to get to the hospital was another pre-hospital EMS quality measure. **Figure 10** shows some improvement in the percentage of STEMI patients with time from ambulance arrival to hospital of 20 minutes or less, although there is also wide variation in the data. The decline in the Fiscal Year 2020 Quarter 4 results may have been affected by the COVID-19 pandemic, which diverted

EMS and hospital staff to focus mostly on COVID-19 patients and also required some EMS staff to work in other cities that were more affected by the pandemic.

**Figure 10. Percent of STEMI Patients with Time from Ambulance Arrival to Hospital Arrival ≤ 20 Minutes**



Source: IHME Analysis of HeartRescue China Patient Registry Data

### III. Lessons Learned

**EMS staff training and data-based quality improvement was effective.** By using data on time to reperfusion and other time-based quality measures to educate and train staff, HRC promoted quality improvement of EMS care. Training sessions focused on the importance of the time-based clinical guidelines, the use of quality improvement methods with data feedback, and testing the effectiveness of interventions in clinical procedures or operations.

**Developing EMS dispatchers' communication skills improves their responses to callers.** The EMS dispatch call data showed that 70% of the 120 emergency telephone calls were non-emergency calls. These non-emergency calls consumed significant emergency call center staff time and resources and caused potential delays in true emergency dispatches. Thus, expanded education interventions targeted Suzhou city residents and EMS call center staff on effective communication during emergency calls. For residents, this training included understanding the nature of a true emergency and how to use clear and concise information to describe symptoms. For EMS dispatching staff, this training included how to ask callers clear questions and then act quickly to provide ambulance staff with relevant information.

## E. Hospital Interventions, Results, and Lessons Learned

### I. Interventions

The HRC hospital interventions focused on the *problems* of initially limited knowledge of STEMI clinical guidelines and efficient patient flows among hospital ED and cardiology department staff, a need for training among clinical staff for STEMI treatment protocols, and lack of data availability and feedback to assess the current situation and track progress. As a result, the HRC hospital *interventions* included a dual focus on the participating hospitals' EDs and cardiology departments, including changing systems, using updated technologies, staff training, and motivating cardiology staff.

#### Key Interventions

- 906 doctors trained
- 1,908 nurses, paramedics, and non-clinical staff trained

**Improving workflow.** HRC conducted ongoing assessments and improvements to ED workflows and procedures, such as colored floor directions and a green channel for STEMI patients, to improve the speed of reperfusion treatment. To reach underserved populations better, HRC developed ED procedures and policies allowing individuals with acute CVD events to be diagnosed and treated without patients fearing about affordability.

#### New HRC Hospital Interventions

- Color-coordinated workflows
- RF reader technology
- STEMI clinical guidelines
- ECG testing
- Treatment protocols with medications and PCI
- Checking and improving data quality
- Using data to identify quality of care problems and opportunities
- Staff incentives

Technology, such as the RF reader technology, automatically recorded a patient's time of entry into the ED, the time when treatment is initiated, and the time for disposition for hospital treatment or ED discharge. HRC encouraged the use of communications and data collection technologies in the

ED to interact with the EMS, including direct video and audio communications links.

**Ongoing Staff Training.** HRC implemented semi-annual training for ED doctors, nurses, and staff on clinical guidelines for treatment of STEMI and other acute cardiovascular events. Trainees received HRC, CEMA, and American Hospital Association certificates, which require complete refresher courses every 2 years. HRC also provided ongoing training for ED doctors, nurses, and staff on data collection and medical records, including checking data completeness, auditing data accuracy against

the medical records, and working with each hospital's HRC data coordinator. ED doctors, nurses, and staff also participated in semi-annual training on quality improvement using data feedback. This training included analyzing data to identify quality of care problems and opportunities for quality improvement and using PDSA cycles to test the effectiveness of interventions in clinical procedures or operations.

**Motivating Hospitals' Cardiology Departments.** Cardiology staff conducted ongoing meetings to review and expand methods for including HRC quality of care data in the calculations of incentives and bonus payments for doctors. Before HRC, doctors' incentives were calculated only on the volume of services they provided and not on quality of the care.



*HeartRescue China training for hospital ED staff*

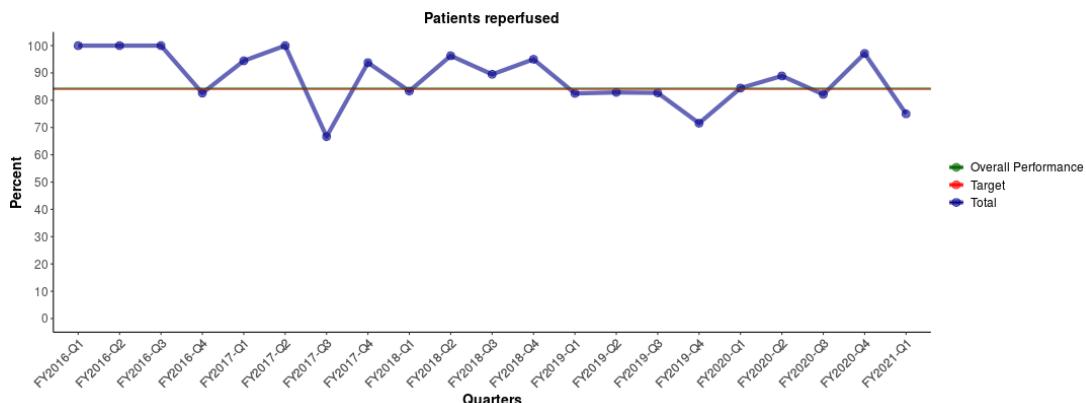
Dr. Zhi-Jie Zheng and Dr. Lin Zhang conducted semi-annual training for cardiology department doctors, nurses, and staff on clinical guidelines for treatment of STEMI and other acute cardiovascular events. This included both diagnosis and treatment protocols for STEMI patients.

## **II. Results**

Because many of HRC hospital quality measures were already at high performance levels, there was limited room for additional quality improvement. Accordingly, performance targets for each quality measure were not much higher than average overall performance over the time period in which data were collected. **Figure 11** shows the high percentages of patients receiving the evidence-based reperfusion treatment in EDs

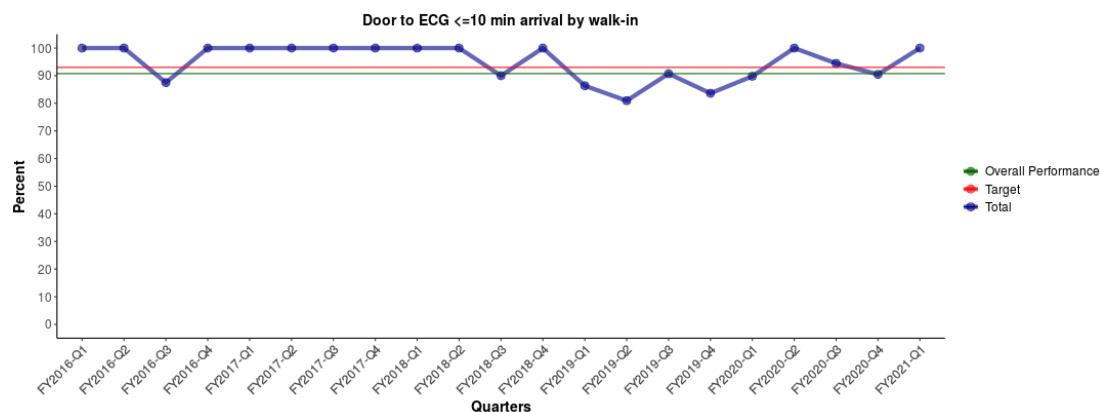
throughout the HRC program. Similarly, **Figure 12** shows a consistently high percentage of patients who receive ECGs within 10 minutes of hospital arrival. The time to PCI treatment for STEMI patients after hospital arrival is an important measure that can reduce heart damage. **Figure 13** shows that the percent of patients receiving PCI treatment within 60 minutes improved over time after multiple hospitals had joined the HRC program in 2018.

**Figure 11. Percent of STEMI Patients Receiving Reperfusion Treatment**



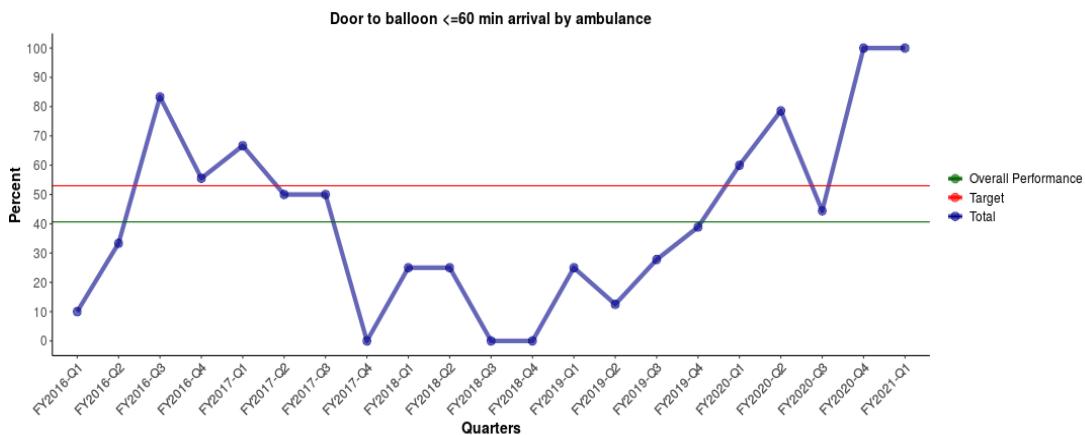
Source: IHME Analysis of HeartRescue China Patient Registry Data

**Figure 12. Percent of Walk-in STEMI Patients with Time from Hospital Arrival to First ECG ≤ 10 Minutes**



Source: IHME Analysis of HeartRescue China Patient Registry Data

**Figure 13. Percent of STEMI Patients with Ambulance Arrival and Time from Hospital Arrival to PCI Treatment ≤ 60 Minutes**



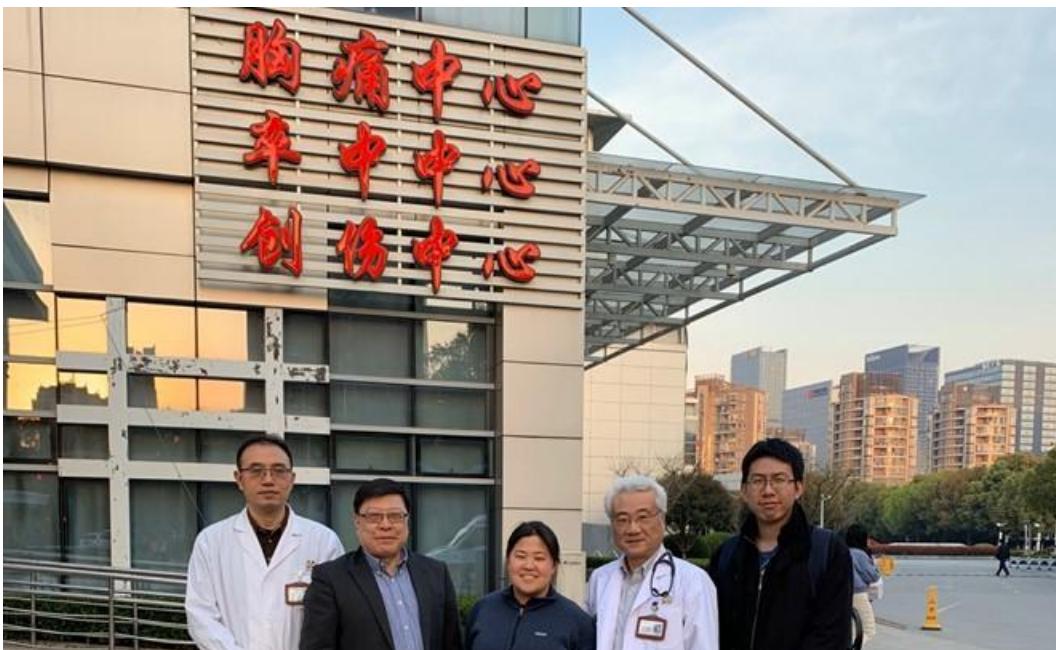
Source: IHME Analysis of HeartRescue China Patient Registry Data

The hospital discharge measures for secondary prevention, including discharges with beta blockers and ACE/ARB medications, did not show significant improvement during HRC (see **Appendix 8** for other HRC hospital quality measure graphs on performance over time). Different types or more intensive interventions could be tested for improved care at the end of the patient's STEMI treatment.

### III. Lessons Learned

**New quality measures are needed for hospitals.** With many hospital quality measures already at high levels, new quality measures with more room for improvement are needed. Possible additional measures include continuity of care after hospital discharge, follow-up care in the community, more effective management of patients' underlying CVD, follow-up appointments, consistent use of secondary prevention medications, and smoking cessation interventions.

**Secondary prevention measures could link to coordination with longer-term chronic CVD patient care.** Secondary prevention quality measures, such as the percent of STEMI patients who received ACE/ARB medications, statins, aspirin, and beta blocker medications, were collected in the HRC patient registry data set. Although doctors, nurses, and data coordinators at the hospitals were trained to collect data on those measures and accurately document them in the medical records, there was still room for improvement. Better data on these measures could allow for more focused coordination of patient's post-discharge care for their underlying chronic CVD.



The Suzhou Kowloon Hospital President and Chief of Cardiology with RTI, CHH, and IHME staff

## F. Sustainability and Future Plans for Scaling Up in China

### I. Sustainability

Chinese governmental support is an important factor for long-term HRC sustainability. HRC worked with the Suzhou Health Bureau to continue to provide care to the people of Suzhou. The Suzhou Municipal Government, as outlined by the Suzhou Health and Family Planning Commission, has made improving access and quality of care for acute cardiac events a major priority for development and improvement in their current 5-year plan. HRC will support the Suzhou Health Bureau's public health initiative known as "531," which focuses on heart attack symptoms for government, EMS, and hospital systems. To support each other and coordinate efforts, HRC and the Suzhou Health Bureau implements processes to collect performance measures and patient data.

HRC worked with the national Chest Pain Centers (CPC) program, which is managed by CHH, to maintain HRC in Suzhou. HRC also plans to maintain existing partnerships and develop new partnerships with medical professional associations and business corporations.

#### HeartRescue China Sustainability Partners

Chinese Cardiovascular Association, Chinese Society for Emergency Medical Response, Chinese College of Physicians, Chinese Medical Association, Chinese Association of Preventive Medicine, AMSN, AstraZeneca, Sanofi, Laerdal, PhysioControl, Medical System, and Zoll

Findings from HRC have been published in journal articles and presented at conferences to publicize HRC (see **Appendix 9** for a list), and more publications are planned.

## II. Scaling Up

HRC is working with the CHH's CPC Program to scale up intervention efforts through their national programs. Before HRC's involvement, there were few quality measures actively monitoring the quality of care for patients with STEMI and other CVDs. Several HRC quality measures were implemented by the CPC, such as door to balloon time (hospital arrival to PCI time), reperfusion, and time from first medical system contact to reperfusion. To provide some time for the 2,756 CPC-registered hospitals to become familiar with these measures and adapt to HRC's more stringent requirements, measures are introduced first for monitoring purposes. The plan is to gradually introduce more of the HRC quality measures into the CPC accreditation requirements in the coming year as part of the scaling up process to expand HRC into the CPC-registered hospitals to increase the quality standards for CPC accreditation.



*China Heart House staff at the CHH Headquarters in Suzhou*

Although many hospitals have been accredited in CPC, many more participate to a lesser degree, indicating the potential for scaling up the HRC quality measures and interventions. As of November 2019, there were 3,915 hospitals across 31 provinces participating in CPC, including the 2,756 hospitals registered and contributing clinical data to CPC and 785 hospitals fully accredited by the CPC. **Appendix 10** includes a map showing the provincial distribution of CPC hospitals across China.

The focus of the CPC accreditation program has traditionally been on hospital quality measures, but because of the HRC community and EMS efforts, CPC plans to expand accreditation to include pre-hospital quality measures. The CHH held a conference in Suzhou in December 2019 for all hospitals across China, including hospitals currently CPC accredited and others seeking accreditation. The conference highlighted efforts by HRC and examined how expanding CPC quality measures could improve EMS and community factors related to quality of care throughout China.



*HeartRescue Brazil training for hospital staff*

## Section 4. HeartRescue Brazil

### A. Background and Partners

To improve access and quality of care for STEMI patients in the city of VDC, HRB included interventions across the three settings of care: (1) communities, (2) pre-hospital EMS, and (3) hospitals. VDC is an important regional center for receiving health care, with several smaller cities in its surrounding region in the states of Bahia and Minas Gerais. HRB was led by Dr. Renato Lopes and Dr. Pedro Barros from the Brazilian Clinical Research Institute (BCRI), with assistance from the Federal University of Bahia (FUB) in VDC and with supervision and technical assistance from RTI. HRB began operations in 2018 and continued through 2020, although it was hampered by the spread of the COVID-19 in Brazil in 2020.

**HRB's Catchment Area  
Included 400,000 People.  
Underserved Populations  
Included**

- 43% low income
- 13% illiterate

A unique feature of HRB was that it built upon the HealthRise Brazil project, a prior Medtronic Foundation project. HealthRise established strong relationships with the local government's community health workers who provide community outreach, chronic disease screening, and chronic disease management services in VDC. Faculty from the local FUB, who had recently managed the HealthRise Brazil program, also joined the HRB team. As a result of the efforts of the HealthRise Brazil project in VDC, HRB was able to benefit from and build on established community networks and governmental support, including the government's EMS system, SAMU 192. Other local partners are listed in **Appendix 11**.

## B. Data Systems for Quality Improvement

HRB's data system for quality improvement addressed the *problems*: lack of data for assessing current levels of STEMI access and quality of care, lack of data trends over time to track progress, and lack of data feedback to providers for support quality improvement. As a result, the HRB data system *interventions* included a STEMI patient registry, quality measures, and non-registry data on HRB program processes. BCRI developed a central database with data collected from community education events, EMS, and participating hospitals. HRB staff created standardized reports to conduct and review data analyses each month, to provide feedback for quality improvement meetings with EMS agency and participating hospitals, and to check and improve the quality of the HRB data. However, the COVID-19 pandemic interrupted the data collection and feedback efforts before they could be rolled out in detail for quality improvement with the participating EMS agency and hospitals. Institutional Review Board (IRB) delays at the outset of HRB also limited the time available for data collection and feedback.

### Data System Results

54 STEMI patients tracked in the HRI patient registry (data collection was interrupted by the COVID-19 pandemic in 2020)

HRB quality of care assessments were based on a set of 29 quality measures, including 10 pre-hospital measures, 12 in-hospital measures, and seven hospital discharge measures. The full list of measures is in **Appendix 12**. Although the COVID-19 pandemic halted data collection, the patient registry currently has data on 54 STEMI patients, including 28 intervention patients and 26 patients from a pre-HRB retrospective comparison group. Data collection will be able to resume once the COVID-19 pandemic ends, as discussed in the HRB sustainability plan below.

## C. Community Setting

### I. Interventions

Community interventions focused on the *problems* of lack of knowledge of heart attack symptoms, not understanding the need to quickly call for medical help when those symptoms happen, and delays of patients and families in seeking medical care because of socioeconomic and cultural barriers. As a result, the HRB community

### Community Activities

- 349 community health workers trained
- 116 schoolteachers trained in recognizing heart attack symptoms and first aid for heart attacks
- 7,273 school children educated in recognizing heart attack symptoms and first aid for heart attacks

**interventions** focused on increasing knowledge and recognition of heart attack symptoms and the importance of quickly calling the emergency telephone number 192 at the onset of heart attack symptoms. The interventions included two major activities:

- 1. Community education of local government's community health workers.** HRB's training for community health workers enabled them to recognize heart attack symptom and understand the need to act quickly when those symptoms happen. The HRB training included topics on definitions and identification of heart attack symptoms, heart attack prevalence in Brazil, risk factors for cardiovascular disease, and step-by-step action plans for patients and families that encourages acting quickly when those symptoms occur.
- 2. Training in the local government schools.** The HRB curriculum promoted knowledge of heart attack symptoms, instructed on first aid for heart attacks, and explained how patients and families can respond quickly when those symptoms occur. The VDC government approved this curriculum for use in all of the local high schools.

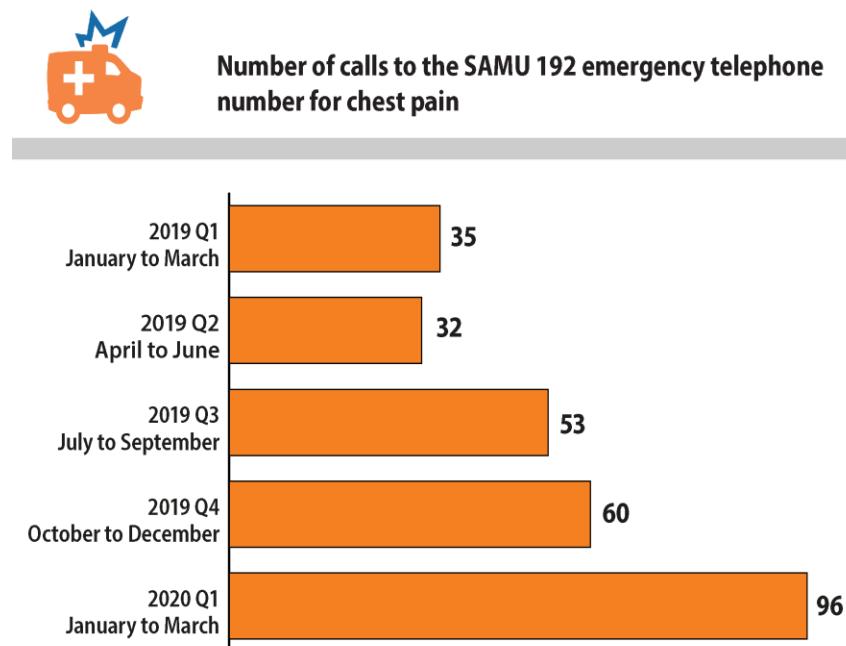


HeartRescue Brazil community health workers

## II. Results

Calling an emergency telephone number is a main way that community members can act to help individuals who are experiencing heart attack symptoms. The number of calls to the SAMU 192 emergency telephone number for chest pain increased significantly following the start of the HRB community education program, as shown in **Figure 14**.

**Figure 14. Number of Calls to the SAMU 192 Emergency Telephone Number for Chest Pain**



Source: SAMU 192

### III. Lessons Learned

***Building on established projects creates many benefits for continuity and connections.*** BCRI hired a former member of the HealthRise team (and faculty member at FUB) as a consultant to assist with HRB implementation in VDC. His connections throughout VDC facilitated HRB introductions with the local government officials, SAMU 192 EMS staff, and hospital staff, and his support explained the continuity with the HealthRise project. The good reputation of the HealthRise project and his backing proved invaluable in gaining their support for HRB. FUB staff also provided training to the community health workers, schoolteachers, and students, and worked with the hospitals on HRB data collection and data validation.

***Collaboration on data collection can serve multiple projects.*** Another benefit of continuity and collaboration with the HealthRise project included HRB questions in the established HealthRise community survey. By working with the evaluation partner IHME on both projects, one community survey served the needs of both projects and provided community data much more quickly to HRB staff. Without this connection, the HRB project would not have developed and implemented its own survey in such a short time.

Seeking similar opportunities for collaboration on data collection should also be considered for future projects.

## D. Pre-hospital EMS Setting

### I. Interventions

The pre-hospital EMS interventions focused on the **problems** of implementing clinical guidelines for STEMI treatment, goals for reducing time to treatment, and data collection and feedback to track progress and support quality improvement. As a result, the HRI **interventions** included three main activities:

1. Working with the governmental SAMU 192 EMS system to develop new clinical guidelines for STEMI treatment and to provide training on them.
2. Working with SAMU 192 to reactivate the “Motolance” motorcycle ambulance to provide faster assistance to patients and families.
3. Training for SAMU 192 staff on collecting high-quality data and using the data to test whether clinical process changes improve care for STEMI patients.

### II. Results

After less than 1 year of data collection, HRB was interrupted by the COVID-19 pandemic. Thus, results are not yet available for the pre-hospital EMS quality measures.

### III. Lesson Learned

***Support from the local government allows for more widespread training and education programs.*** In Brazil, support from the local government is critical for community education and public health care services. HRB benefitted from the positive experiences between the VDC local government and the Medtronic Foundation’s HealthRise project. As a result, the local government actively supported the implementation of the SAMU 192 EMS system, community health worker training, and local school education programs. The SAMU 192 staff were active collaborators on HRB interventions both for EMS and in assisting with training in the schools education program.



*HeartRescue Brazil training by SAMU 192 EMS staff*

## E. Hospital Setting

### I. Interventions

The HRB hospital interventions focused on two **problems**—that only the VDC General Hospital provided reperfusion treatment (via thrombolytic medications) for STEMI patients as a part of the public sector health care system and that the other VDC hospitals and public acute care unit did not have STEMI protocols to guide treatment. The HRB hospital **Interventions** included three main activities:

1. Working with the participating hospitals to develop and implement new clinical guidelines for STEMI treatment for both public and private sector patients.
2. Working with the public and private hospital cardiology staff to expand the times that PCI was available in the private hospitals to treat STEMI patients so that patients have full care coverage any time of the day or night, 24/7, instead of the limited times it had previously been available.
3. Training hospital staff on how to collect high-quality data and use these data to test whether clinical process changes improve care for STEMI patients.

### II. Results

As noted above, results are not yet available for the hospital quality measures because of interruptions in data collection from the COVID-19 pandemic.

### III. Lesson Learned

#### ***Variations in hospital data systems required hospital-specific approaches for improving data quality.***

In developing the STEMI patient registry, HRB encountered a number of data quality problems. A particular problem was missing patient information in the electronic case report form because of a lack of patient data in the medical records, patient transfers with other hospitals that did not adequately track prior medical treatments, and difficulties in obtaining patient discharge information. These data quality challenges varied among the participating hospitals, so HRB developed individualized methods for following up and improving medical chart documentation for STEMI patients at each hospital.

#### ***Focus on community interventions and planning if there are delays with hospitals' IRB approvals.***

Review and approval of the HRB hospital interventions and data collection took many months for all participating hospitals, leading to delays in HRB implementation. Because data collection cannot begin without IRB approval, future projects should anticipate these delays, quickly submit IRB applications at the outset, and follow up quickly on revision requests. During the delays, HRB focused instead on community programs, such as training community health workers, and improved plans for the EMS and hospital interventions and the data collection procedures.

## F. Sustainability and Future Plans for Scaling Up in Brazil

### I. Sustainability

The HRB team arranged for the interventions to be sustainable, including the community engagement programs, pre-hospital EMS response, and hospital care improvements, at the end of the Medtronic Foundation grant. The Secretary of Health in VDC established a memorandum of understanding in support of the HRB Program. This support will allow future HRB programs to leverage local governmental resources, including the public hospitals, SAMU 192, community health workers, and the schools for sustainability goals. For the HRB school program, the local government (in VDC prefecture) committed to supporting this program in December 2019. The government approved the implementation of the HRB curriculum in all of the local high schools. This enabled government-funded schools to sustain the HRB training, and SAMU 192 committed to serve as a local resource to assist the schoolteachers with this curriculum.

The sustainability plan also includes a local VDC system of care for STEMI patients called “Plantão do Infarto.” This system integrates SAMU 192 and the hospitals to enable more effective communication related to acute care. The hospitals will also continue to

provide data on quality measures and review opportunities for quality improvement. A partnership with the pharmaceutical company Boehringer Ingelheim will ensure that all participating HRB team members have ongoing access to their web-based training platform. The platform has a range of benefits for participating providers, including training on the diagnosis and treatment for heart attacks and other acute diseases (e.g., stroke).

## II. Scaling Up

HRB and Boehringer Ingelheim also developed an initiative to adapt and scale up their web-based physician training platform based on the HRB project. In the initiative, physicians and nurses from local Brazilian communities will complete an online course focused on better diagnosis and treatments for patients with STEMI. A representative of Sociedade Norte-Nordeste de Cardiologia attended the VDC meeting in November 2019 and discussed the possibility of making this platform available to all health care providers in the North and Northeast regions of Brazil. Plans could also target cardiologists in those regions. This effort was delayed by the spread of the COVID-19 pandemic in Brazil in 2020 but will resume once the pandemic subsides.



*HeartRescue Brazil community training*

## Appendix 1

### HeartRescue India Local Partners



#### Hospital Partners

##### Hub Hospitals

- M.S. Ramaiah Hospital
- Suguna Hospital

##### Spoke Hospitals

- Santosh Hospital
- People Tree Hospital
- Aveksha Hospital
- Ananya Hospital
- Sreenivasa Hospital



#### Partner Schools

- Panchajanya Vidyapeeth
- Ashwin Vidyalaya
- M.S. Ramaiah High School
- Cambridge English School
- St. Charles School

- M.S. Ramaiah Vidyanikethan
- Gnana Teja English High School
- St. Loudes High School
- St. Antony Claret School
- New Carmel



## Government, Community, and Business Partners

### Government Partners

- Jayadeva Government Hospitals
- City of Bangalore Civil Defense
- City of Bangalore 108 EMS
- City of Bangalore Police
- Karnataka State Ministry of Health
- Government of India Ministry of Health
- Chicago Fire Department

### Community Partners

- Indian Centre for Social Transformation
- Karnataka Health Promotion Trust
- Home Guard
- Bangalore Rotary International
- Red Cross
- Illinois HeartRescue
- American Heart Association

### Business Partners

- Kallows Engineering India Pvt Ltd
- Narayana Health RFID Technologies
- Gokula Metropolis Lab
- ScribeTech
- Masimo
- Mentric Training & Consultation Pvt Ltd
- Inkers
- AstraZeneca
- Laerdal

## Appendix 2

### HeartRescue India Quality Measures



#### Pre-hospital Quality Measures

- Number of calls to the central call center per month (rolling total to track usage)
- Time from MI symptom onset to first medical system contact (call placed to central emergency call center) for STEMI patients with a goal of ≤ 60 minutes.
- Time from initial call placed to central emergency call center to nurse motorcycle arrival for STEMI patients, with a goal of ≤ 15 minutes.
- Time from initial call placed to central emergency call center to first 12-lead ECG for STEMI patients, with a goal of ≤ 30 minutes.
- Time from first responder ECG diagnosis of STEMI to first hospital arrival, with a goal of ≤ 30 minutes.
- Time from initial call placed to emergency call center to first hospital arrival, with a goal of ≤ 60 minutes from call center call.
- Percent of STEMI patients arriving at the first hospital by ambulance.
- Percent of STEMI patients with cardiac arrest in a pre-hospital setting and survival to hospital.
- Time from MI symptom onset to first reperfusion (either thrombolytic medications or PCI) for STEMI patients, with a goal of ≤ 180 minutes.
- Time from first medical system contact (first eye-to-eye contact between STEMI patient and first responder) to first reperfusion (either thrombolytic medications or PCI) for STEMI patients, with a goal of ≤ 90 minutes.



## In-Hospital Quality Measures

- Door to ECG time for STEMI patients arriving at the hospital by ambulance, with a goal of ≤ 10 minutes.
- Door to ECG time for STEMI patients arriving at the hospital by walk-in, with a goal of ≤10 minutes.
- Door to needle time for STEMI patients arriving at the hospital by ambulance, with a goal of ≤ 30 minutes.
- Door to needle time for STEMI patients arriving at the hospital by walk-in, with a goal of ≤ 60 minutes.
- Door to balloon time for STEMI patients arriving at the hospital by ambulance, with a goal of ≤ 60 minutes.
- Door to balloon time for STEMI patients arriving at the hospital by walk-in, with a goal of ≤ 90 minutes.
- Percent of STEMI patients receiving any reperfusion (either thrombolytic medications or PCI).
- Percent of STEMI patients receiving PCI.
- Percent of STEMI patients with survival to hospital discharge (in-hospital mortality).
- Percent of STEMI patients with adverse events in the hospital (heart failure, stroke, bleeding requiring transfusion).



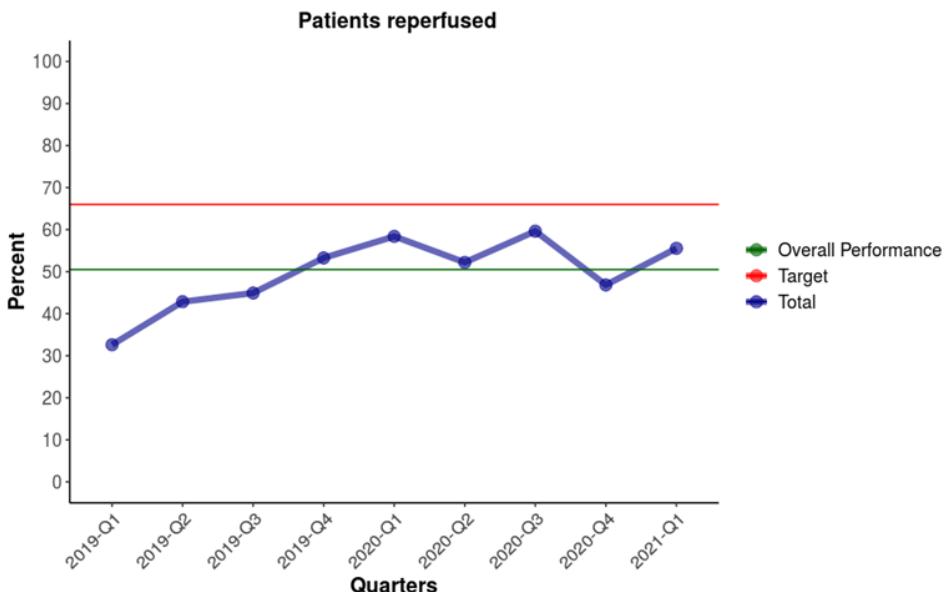
## Hospital Discharge Quality Measures

- Percent of patients discharged from the hospital with a beta blocker.
- Percent of patients discharged from the hospital with ACE/ARB.
- Percent of patients discharge from the hospital with ASA.
- Percent of patients discharged from the hospital with a statin.
- Percent of patients who report tobacco use discharged from the hospital with smoking cessation counseling.
- Percent of STEMI patients discharged from the hospital who have a follow-up appointment.

### Appendix 3

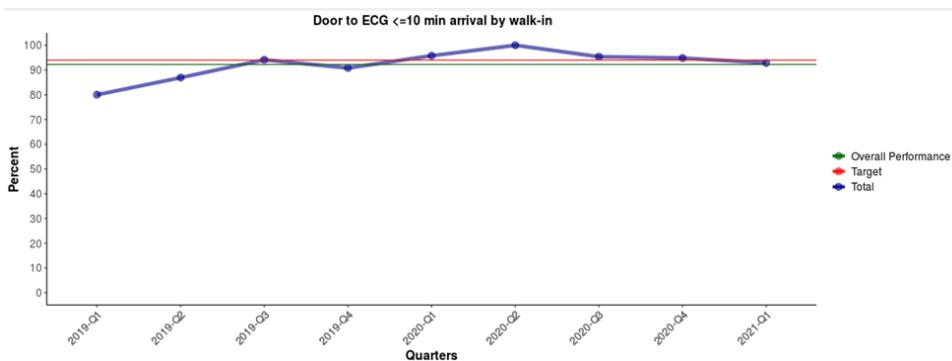
#### Additional HeartRescue India Quality Measure Data Graphs

**Figure A3A. Percent of All STEMI Patients Reperfused**

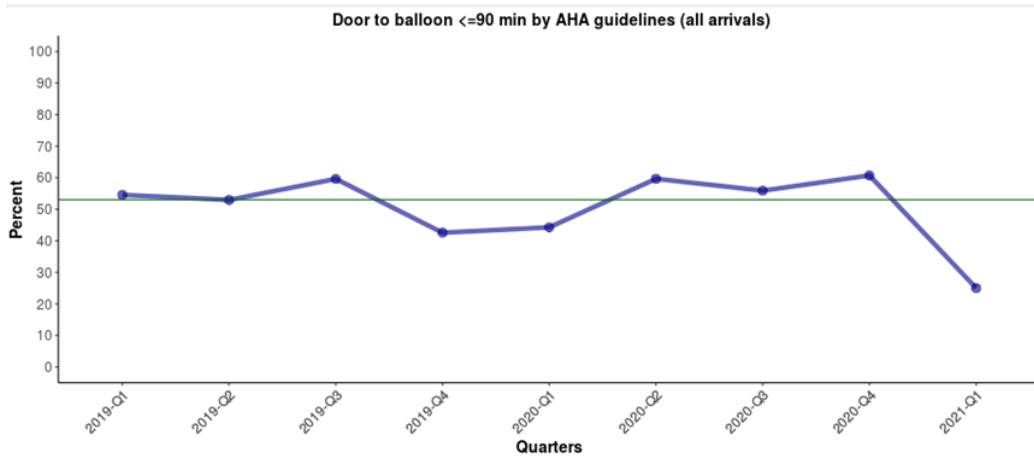


**Source:** IHME Analysis of HeartRescue India Patient Registry Data

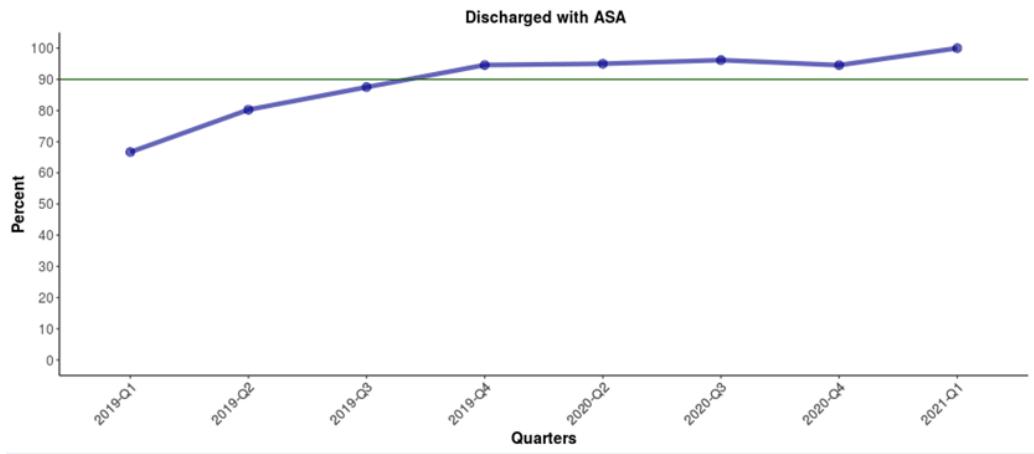
**Figure A3B. Percent of STEMI Patients with Time from Hospital Arrival to ECG Less Than 10 minutes for Patients with Arrival by Walk-in**



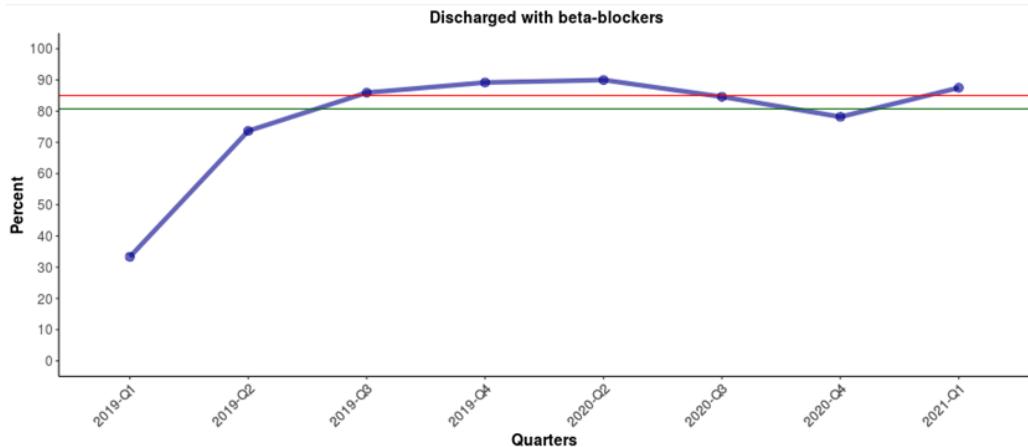
**Source:** IHME Analysis of HeartRescue India Patient Registry Data

**Figure A3C. Percent of All STEMI Patients with Time from Hospital Arrival to PCI Less Than 90 minutes**

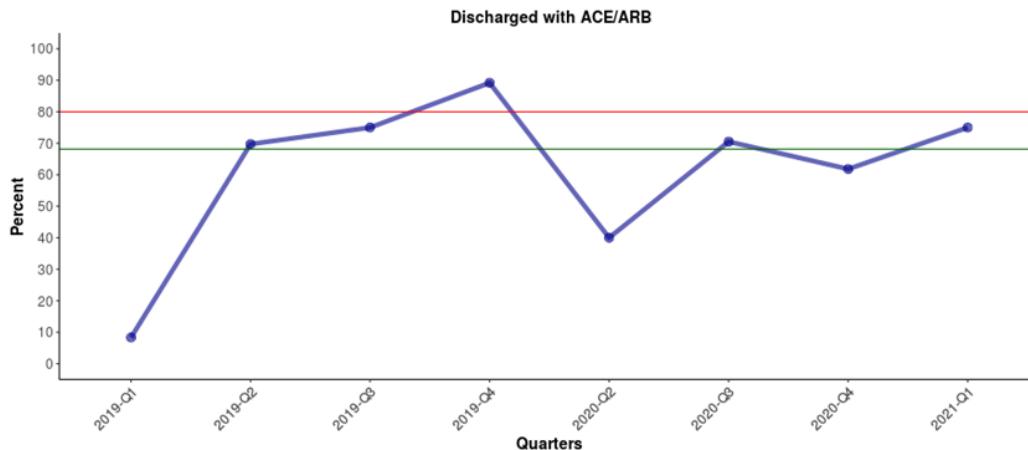
**Source:** IHME Analysis of HeartRescue India Patient Registry Data

**Figure A3D. Percent of STEMI Patients Discharged with Aspirin**

**Source:** IHME Analysis of HeartRescue India Patient Registry Data

**Figure A3E. Percent of STEMI Patients Discharged with Aspirin**

**Source:** IHME Analysis of HeartRescue India Patient Registry Data

**Figure A3F. Percent of STEMI Patients Discharged with Aspirin**

**Source:** IHME Analysis of HeartRescue India Patient Registry Data

## Appendix 4

### HeartRescue India Partners for Sustainability

- Rotary Club
- Karnataka Health Promotion Trust
- Civil Defense Ministry
- Ramaiah International Center for Public Health Innovation
- Schools in Bangalore
- Jayadeva Hospital
- 108 Emergency Medical System
- Rajiv Gandhi University of Health Sciences
- Embassy Tech Park
- Ministry of Health at the Karnataka state and national levels
- American Association of Physicians of Indian Origin.
- Astra Zeneca
- Laerdal
- Infosys
- Biocon
- Narayana Health.

## Appendix 5

### HeartRescue India Journal Articles and Conference Presentations

#### **Journal Articles**

Ramesh A, LaBresh KA, Begeman R, Bobrow B, Campbell T, Chaudhury N, Edison M, Erickson TB, Manning JD, Prabhakar BS, Kotini-Shah P, Shetty N, Williams PA, VandenHoek T. Implementing a STEMI system of care in urban Bangalore: Rationale and Study Design for Heart Rescue India. Contemporary Clinical Trials Communications; 2018, 10: 105-110.

Chauhan V, Shah PK, Galwankar S, Sammon M, Hosad P, Erickson TB, Gaiesski DF, Grover J, Hegde AV, Vanden Hoek T, Jarwani B, Kataria H, LaBresh KA, Manjunath CN, Nagamani AC, Patel A, Patel K, Ramesh D, Rangaraj R, Shamanur N, Sridhar L, Srinivasa KH, Tyagi S. The 2017 International Joint Working Group recommendations of the Indian College of Cardiology, the Academic College of Emergency Experts, and INDUSEM on the management of low-risk chest pain in emergency departments across India. Journal of Emergencies, Trauma, and Shock; 2017, 10(2): 74.

Erickson T, Ramesh A, VandenHoek T, Shetty N, LaBresh K, Edison M, Begeman R, Kotini O, Prabbakar B. Development of a nurse-paramedic model for acute STEMI/SCA care in India. Annals of Global Health; 2016, 82(3): 415.

Ramesh A, Vanden Hoek TL, LaBresh K, Campbell T, Murthy K, Shetty N, Begeman RM, Edison M, Williams P, Prabhakar BS, Erickson TB. Development of an emergency nurse-paramedic motorcycle response system for acute STEMI and sudden cardiac arrest care in India. Global Journal of Emergency Medicine; 2018, 1(2): 1008.

#### **Conference Presentations and Posters**

- Society for Emergency Medicine India EMCON:
  - November 2017: The HRI team shared insights on the Heart Rescue programs in India, Illinois, China, and Brazil along with STEMI, cardiac arrest, and quality improvement strategies.
  - November 2018: An 8.5- hour Pre-Hospital Seminar conducted by Teri Campbell and Ian Nygen. This included 90 attendees for a review of pre-hospital-hospital protocols/safety standards, skill training, and follow-up skill demonstrations.

- November 2018: Teri Campbell gave a lecture on "Paramedics in the West," A history of para-medicine in the west and included information from not only the United States but also Canada, Great Britain, and Israel. In addition to giving the history, Teri discussed the evolving and expanded role of pre-hospital providers, including EMTs, EMTPs, RTs, RNs, and MDs.
  - November 2017, First World NCD Congress, Chandigarh, India, Community Preparedness and System Goals for Reperfusion Therapy in STEMI.
- November 2017, First World NCD Congress, Chandigarh, India., Dr. Aruna Ramesh participated in a Round Table for Multisectoral Ministries and key stakeholders for NCDs.
- October 2018, 11 World Stroke Congress, Montreal, Canada: Will a Hub and Spoke Hospital Help Desk Model Trigger patients to act fast.
- January 2019, Prince Mahidaol Conference, Thailand: A Multinational Alliance for NCD Health Equity built upon Government and Community Partnerships for Emergency Access to Care: The Heart Rescue Program.
- April 2019: Dr. Vanden Hoek, Dr. Aruna Ramesh, and Dr. Bellur Prabhakar from HRI presented at the AHANI India conference led by Dr. Nayanjeet Chaudhury from the Medtronic Foundation.
- July 2019, American Associate of Physicians of Indian Origin Global Healthcare Summit, Hyderabad, India. Dr. Aruna Ramesh from HRI presented on Resuscitation Challenges and Dr. Murthy from HRI presented on providing advances in resuscitation and a simulation session along with a panel discussion.
- September 2019, Life Sciences & Healthcare Innovation Forum, Redefining the Healthcare Landscape – The Digital Shift. Dr. Aruna Ramesh was a Panel Discussant.
- September 2019 Indian College of Cardiology Conference, Kochi, India. Presentations:
  - Dr. Aruna Ramesh, Timely Action Matters in Acute Cardiovascular Disease
  - Dr. Kenneth LaBresh, ACS: STEMI/NSTEMI
  - Dr. Terry Vanden Hoek, Sudden Cardiac Arrest
  - Dr. Aruna Ramesh, Heart Rescue India, the Bangalore Project
  - Dr. Anupama Hedge, Quality Measures in HRI
  - Dr. Pedro Barros, Telemedicine
- Poster Presentations:
  - Community Engagement Strategies -- Responding to an Acute Cardiovascular Event.

- Training High School Children in Integrated Bystander Response and Hands Only CPR: A Novel and Comprehensive program in Urban Bangalore.
- November 2019, American Public Health Association 2019 Annual Meeting, Philadelphia: A Cardiovascular Education Program for Youth in Bangalore, India, APHA 2019 Annual Meeting: Philadelphia.
- May 2020, Society of Academic Emergency Medicine, Denver: Gender Disparities in ST-Elevation Myocardial Infarction: A Multi-center Prospective Study in Bengaluru, India.

## Appendix 6

### HeartRescue China Local Partners



#### Hospitals

- Suzhou Kowloon Hospital
- Suzhou University Affiliated No. 1 Hospital
- Suzhou University Affiliated No. 2 Hospital
- Suzhou City Hospital
- Xi Hai Hospital

#### Government Agencies

- Suzhou Health Bureau
- Suzhou EMS Agency
- Suzhou Center for Disease Control
- Suzhou Community Health Centers
- Suzhou Industrial Park Social Development Bureau

#### Universities

- Peking University Health Sciences Center
- Shanghai Jiao Tong University
- Shanghai University of Medicine and Health Sciences

#### Businesses

- Laerdal (staff time and training manikins)
- AMSN, Inc. (training services)

## Appendix 7

### HeartRescue China Quality Measures



#### Pre-hospital Quality Measures

- Number of STEMI patient calls to the central emergency call center per month.
- Time from MI symptom onset to first medical system contact (call placed to central emergency call center or walk-in to the ER) for STEMI patients with a goal of ≤ 60 minutes.
- Time from initial call placed to central emergency call center to ambulance arrival for STEMI patients, with a goal of ≤ 15 minutes.
- Time from ambulance arrival to first 12-lead ECG for STEMI patients, with a goal of ≤ 10 minutes.
- Time from ambulance ECG diagnosis of STEMI to first hospital arrival, with a goal of ≤ 15 minutes.
- Time from ambulance arrival to STEMI patient to first hospital arrival, with a goal of ≤ 20 minutes.
- Time from initial call placed to the emergency call center to first hospital arrival for STEMI patients, with a goal of ≤ 30 minutes.
- Percent of STEMI patients arriving at the first hospital by ambulance.
- Time from MI symptom onset to first reperfusion (either thrombolytic medications or PCI) for STEMI patients, with a goal of ≤ 180 minutes.
- Time from first medical system contact (call placed to central emergency call center or walk-in to the ER) to first reperfusion (either thrombolytic medications or PCI) for STEMI patients, with a goal of ≤ 90 minutes.



## In-Hospital Quality Measures

- Door to ECG time for STEMI patients arriving at the hospital by ambulance, with a goal of ≤ 10 minutes.
- Door to ECG time for STEMI patients arriving at the hospital by walk-in, with a goal of ≤ 10 minutes.
- Door to needle time for STEMI patients arriving at the hospital by ambulance, with a goal of ≤ 30 minutes.
- Door to needle time for STEMI patients arriving at the hospital by walk-in, with a goal of ≤ 60 minutes.
- Door to balloon time for STEMI patients arriving at the hospital by ambulance, with a goal of ≤ 60 minutes (for primary PCI).
- Door to balloon time for STEMI patients arriving at the hospital by walk-in, with a goal of ≤ 90 minutes (for primary PCI).
- Percent of STEMI patients receiving any reperfusion (either thrombolytic medications or PCI).
- Percent of STEMI patients receiving PCI.
- Percent of STEMI patients receiving optimal reperfusion.
- Percent of STEMI patients with survival to hospital discharge (and not transferred to another hospital).



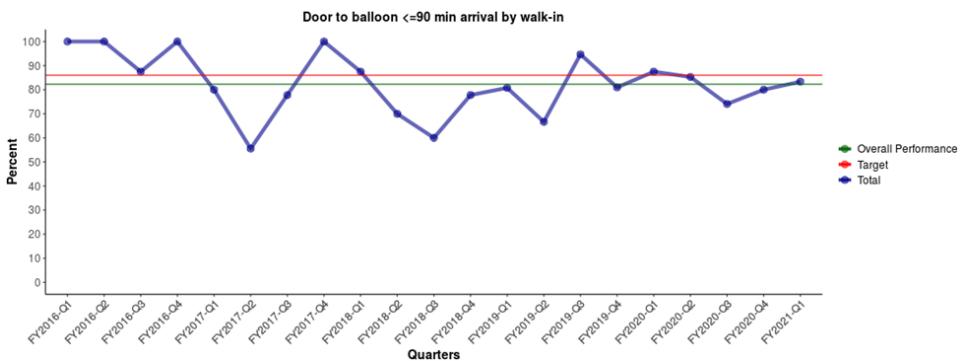
## Hospital Discharge Quality Measures

- Percent of patients discharged from the hospital with a beta blocker.
- Percent of patients discharged from the hospital with ACE/ARB.
- Percent of patients discharge from the hospital with aspirin.
- Percent of patients discharged from the hospital with a statin.

## Appendix 8

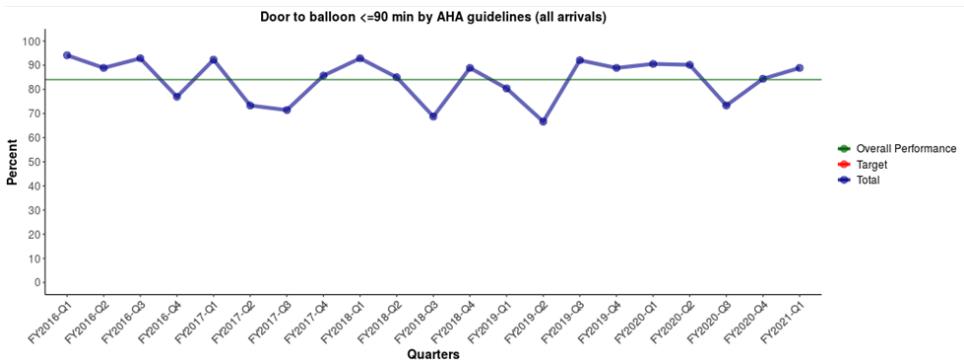
### Additional HeartRescue China Quality Measure Data Graphs

**Figure A8A. Percent of STEMI Patients With Time from Hospital Arrival to PCI of 90 Minutes or Less for Patients Arriving at the Hospital by Walk-in**



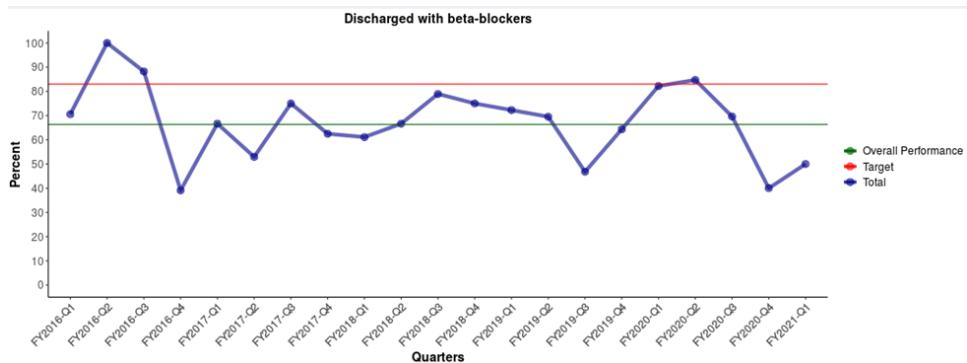
Source: IHME Analysis of HeartRescue China Patient Registry Data

**Figure A8B. Percent of All STEMI Patients With Time from Hospital Arrival to PCI of 90 Minutes or Less**



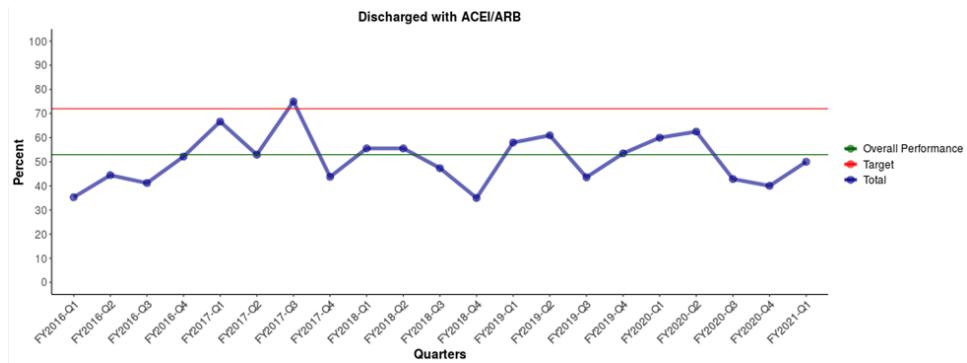
Source: IHME Analysis of HeartRescue China Patient Registry Data

### Figure A8C. Percent of STEMI Patients Discharged with Beta-Blockers



Source: IHME Analysis of HeartRescue China Patient Registry Data

### Figure A8D. Percent of STEMI Patients Discharged with ACEI/ARB



Source: IHME Analysis of HeartRescue China Patient Registry Data

## Appendix 9

### HeartRescue China Journal Articles and Conference Presentations

#### **Journal articles published or accepted for publication**

Liu F, Zhang L, Ge M, Xing J, You B, Zhang X, Shi O, Bobrow B, LaBresh K, Trisolini M, Z. Zheng. Public health interventions to improve access and quality of care for patients with acute cardiac events: overview of the HeartRescue China program. *Cardiology Plus* 2016;1(2): 30-37.

Zhang L, Luo M, Myklebust H, Pan C, Wang L, Zhang X, Zhou Z, Yang Q, Lin Q, Zheng ZJ. When dispatcher assistance is not saving lives: Assessment of process compliance, barriers, and outcomes from out-of-hospital cardiac arrest in a metropolitan city in China. *Emergency Medicine Journal*. Accepted for publication.

#### **Journal articles published in Chinese scientific journals**

Jing SW, Zhang L, Zheng, ZJ, Cao WN. Knowledge and skills of Cardiopulmonary Resuscitation among primary care providers in Suzhou Industrial Park. *Cardiovascular Disease e-Journal* 2017; 5(4): 96-97. 【景诗文、张琳、郑志杰、巢为农，苏州工业园区医护人员心脏急救技能考核调查，《中西医结合心血管病电子杂志》2017年5卷4期96-97页】

Dong XJ, Pan C, Wang L, Luo MY, Yang QY, Zhou ZX, Zheng ZJ, Cao WN, Zhang L. Knowledge and skills of cardiopulmonary resuscitation among health care providers in Suzhou. *Chinese Journal of Emergency Rescues and Disaster Medicine* 2019; 14(1): 46-50 【董雪洁、潘纯、王亮、罗暻悦、杨齐英、周振祥、郑志杰、巢为农、张琳，苏州市医务人员心脏急救理论和操作能力现状研究，《中国急救复苏与灾害医学杂志》2019年14卷1期46-50页】

Zhao XY, Dong XJ, Zhang L, Xiao YY, Li ZH. Automated external defibrillator use in China: current situation and future perspective. *Chinese Journal of Emergency Rescues and Disaster Medicine* 2019; 14(2): 104-107. 【赵旭峰、董雪洁、张琳、肖艳宇、郑志杰、李宗浩，自动体外除颤仪的普及现状及其在我国的应用展望，《中国急救复苏与灾害医学杂志》2019年14卷2期104-107页】

Pan C, Wang L, Yang QY, Zhou ZX, Birkenes TS, Myklebust H, Wu ZX, Luo MY, Zhang L, Zheng ZJ. Effectiveness of CPR high-quality training among Suzhou EMS personnel. *Chinese Journal of Emergency Rescue and Disaster Medicine* 2019;14(6): 512-516. 【潘纯、王亮、杨齐英、周振祥、Tonje Soraas Birkenes、Helge Myklebust,

吴智鑫、罗暻悦、张琳、郑志杰，苏州市急救医护人员心脏急救培训效果及分析，《中国急救复苏与灾害医学杂志》2019年14卷6期512-516页】

Zhou SD, Jin YZ, Zheng ZJ. Optimizing emergency medical system in China: current progress. Chinese Journal of Hospital Management. Accepted for publication.

Ma JX, Jin YZ, Zhang L, Zheng ZJ, Association of the chest pain center accreditation with quality of care for patients with ST-elevated myocardial infarction. Chinese Journal of Hospital Management. Accepted for publication.

#### **Journal article manuscripts under review**

Xiang DC, Jin YZ, Fang WY, Su X, Yu B, Wang Y, Wang WM, Wang LF, Yan HB, Fu XH, Zheng ZJ, Labresh KA, Huo Y, Ge JB. Monitor and improve quality of care for acute cardiac events in China: Designing and implementing the China Chest Pain Center Accreditation Program. Circulation Quality of Care and Outcomes

Xiang D, Jin Y, Fang W, Su X, Yu B, Wang Y, Wang W, Wang L, Yan H, Fu X, Zheng ZJ, Labresh KA, Huo Y, Ge J. Reperfusion times and outcomes for patients with ST-segment-elevation myocardial infarction in China: data from 0.4 million adults in a population-based study. BMJ Quality & Safety.

#### **Presentations**

Zheng ZJ. "Progresses in Cardiopulmonary Resuscitation Research," Annual Conference of the Chinese Emergency Medicine Association. Beijing, China, July 6, 2019.

Zheng ZJ. "Develop a Regionalized Emergency Medical System for Acute Cardiovascular Events," China AED Forum, Shen Zhen, China, Oct 18, 2019.

Zheng ZJ. "Improve Quality of Care for Acute Cardiac Events: Updates from the HeartRescue China Program", Asia-Pacific International Conference on Emergency Medicine. Haikou, China, Nov 29-Dec 1, 2019.

Zheng ZJ. "Telephone-Guided Cardiopulmonary Resuscitation: International Experience and China Practice", Asia-Pacific International Conference on Emergency Medicine, Haikou, Hainan, China, August 15, 2020.

Zheng ZJ. "Telephone-Guided Cardiopulmonary Resuscitation: How to implement TCPR in EMS Call Centers (seminar)," Shenzhen EMS, August 21, 2020.

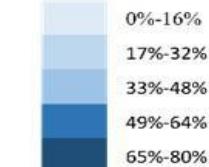
Zheng ZJ. "Mobilizing the community to improve quality of acute cardiac care," China Heart Congress, Shanghai, September 11, 2020.

Zhang, L. "Improving General public's knowledge about CPR and AED: A controlled simulation study." The Navigators Annual Conference, Yinchuan, Oct 10, 2019.

## Appendix 10

### Provincial Distribution of China Heart House Chest Pain Center Program Hospitals

**Percentage of accredited hospitals**



## Appendix 11

### HeartRescue Brazil Local Partners

- Health Secretariat of VDC (local government)
- General Hospital of VDC (governmental)
- IBR Hospital (private)
- Samur Hospital (private)
- Santa Casa Hospital (private)
- SAMU 192 EMS (governmental)
- Acute Care Unit of VDC (governmental)
- Boehringer Ingelheim

## Appendix 12

### HeartRescue Brazil Quality Measures



#### Pre-hospital Quality Measures

- Number of calls to the central emergency call center (SAMU 192) per month.
- Number of calls to the central emergency call center (SAMU 192) per month due to chest pain.
- Time from MI symptom onset to call placed to the central emergency call center (SAMU 192) for STEMI patients arriving by ambulance, with a goal of  $\leq$  60 minutes.
- Time from MI symptom onset to call placed to the central emergency call center (SAMU 192) for STEMI patients, with a goal of  $\leq$  90 minutes.
- Time from initial call placed to the central emergency call center (SAMU 192) to ambulance arrival for STEMI patients arriving at a hospital or health care unit by ambulance, with a goal of  $\leq$  15 minutes.



## In-hospital Quality Measures

- Door to first 12-lead ECG time for STEMI patients arriving a hospital or health care unit, with a goal of ≤ 10 minutes.
- Door to needle time for STEMI patients arriving at the hospital by ambulance, with a goal of ≤ 30 minutes.
- Door to needle time for STEMI patients arriving at the hospital by walk-in, with a goal of ≤ 30 minutes.
- Door to balloon time for STEMI patients arriving at the hospital by ambulance, with a goal of ≤ 60 minutes.
- Door to balloon time for STEMI patients arriving at the hospital by walk-in, with a goal of ≤ 90 minutes.
- Percent of STEMI patients receiving any reperfusion (either thrombolytic medications or PCI).
- Percent of STEMI patients receiving primary PCI.
- Percent of STEMI patients with survival to hospital discharge (in-hospital mortality).
- Percent of STEMI patients with adverse events in the hospital.
- Time from arrival at a non-PCI hospital or health care unit to transfer to a PCI hospital for STEMI patients, with a goal of ≤ 60 minutes.
- Percent of STEMI patients who received ASA in the first 24 hours after hospital admission.
- Percent of STEMI patients who had ejection fraction assessed during hospitalization.



## Hospital Discharge Quality Measures

- Percent of STEMI patients discharged from the hospital with a beta blocker.
- Percent of STEMI patients discharged from the hospital with ACE/ARB.
- Percent of STEMI patients with ejection fraction < 40% who were discharged from the hospital with ACE/ARB.
- Percent of STEMI patients discharge from the hospital with ASA.
- Percent of STEMI patients discharged from the hospital with a statin.
- Percent of STEMI patients who report tobacco use discharged from the hospital with smoking cessation counseling.
- Percent of STEMI patients discharged from the hospital who have a follow-up appointment.