

Flex Monitoring Team Briefing Paper No. 29

Developing Regional STEMI Systems of Care: A Review of the Evidence and the Role of the Flex Program

October 2011



With funding from the federal Office of Rural Health Policy (PHS Grant No. U27RH01080), the Rural Health Research Centers at the Universities of Minnesota, North Carolina, and Southern Maine are cooperatively conducting a performance monitoring project for the Medicare Rural Hospital Flexibility Program (Flex Program). The monitoring project is assessing the impact of the Flex Program on rural hospitals and communities and the role of states in achieving overall program objectives, including improving access to and the quality of health care services; improving the financial performance of CAHs; and engaging rural communities in health care system development.

This report was prepared by John A. Gale, M.S., University of Southern Maine. Questions regarding the report should be addressed to: John Gale at 207-228-8246 or jgale@usm.maine.edu.

The Flex Monitoring team extends its thanks to the following individuals for their invaluable assistance and support in preparing this briefing paper:

- Angela Emge, Hospital Programs Manager, Michigan Office of Rural Health;
- Randy Benson, Executive Director, Rural Health Quality Network;
- Barbara Cote, Director, Total Quality Management, Spectrum Health Reed City Hospital;
- Peggy Jones, Consultant, Illinois Critical Access Hospital Network;
- Melinda Merrell, Director of Hospital Programs, South Carolina Office of Rural Health.

We also extend our thanks to D. Joshua Cutler, M.D., Medical Director, MaineHealth Clinical Integration, Maine Heart Center for his thoughtful review of this briefing paper.

<http://flexmonitoring.org>

University of Minnesota
Division of Health Services Research & Policy
420 Delaware Street, SE, Mayo Mail Code 729
Minneapolis, MN 55455-0392
612.624.8618

University of North Carolina at Chapel Hill
Cecil B. Sheps Center for Health Services Research
725 Martin Luther King Jr. Boulevard, CB #7590
Chapel Hill, NC 27599-7590
919.966.5541

University of Southern Maine
Muskie School of Public Service
PO Box 9300
Portland, ME 04104-9300
207.780.4435

The Medicare Rural Hospital Flexibility Program

The Medicare Rural Hospital Flexibility Program (Flex Program), created by Congress in 1997, allows small hospitals to be licensed as Critical Access Hospitals (CAHs) and offers grants to States to help implement initiatives to strengthen the rural health care infrastructure. To participate in the Flex Grant Program, States are required to develop a rural health care plan that provides for the creation of one or more rural health networks; promotes regionalization of rural health services in the State; and improves the quality of and access to hospital and other health services for rural residents of the State.

The core activity areas of the Flex Grant Program are: 1) support for quality improvement in CAHs; 2) support for financial and operational improvement in CAHs; 3) support health system development and community engagement, including the integration of EMS into local and regional systems of care; and 4) conversion of eligible rural hospitals into CAHs. States use Flex resources for performance management activities, training programs, needs assessments, and network building. The Flex Program is also beginning a new special project, the Medicare Beneficiary Quality Improvement Project (MBQIP) focused on Medicare Beneficiary Health Status improvement.

CAHs must be located in a rural area (or an area treated as rural); be more than 35 miles (or 15 miles in areas with mountainous terrain or only secondary roads available) from another hospital or be certified before January 1, 2006 by the State as being a necessary provider of health care services. CAHs are required to make available 24-hour emergency care services that a State determines are necessary. CAHs may have a maximum of 25 acute care and swing beds, and must maintain an annual average length of stay of 96 hours or less for their acute care patients. CAHs are reimbursed by Medicare on a cost basis (i.e., for the reasonable costs of providing inpatient, outpatient and swing bed services).

The legislative authority for the Flex Program and cost-based reimbursement for CAHs are described in the Social Security Act, Title XVIII, Sections 1814 and 1820, available at http://www.ssa.gov/OP_Home/ssact/title18/1800.htm

TABLE OF CONTENTS

Medicare Rural Hospital Flexibility Program Context	1
Scope of The Problem: St-Segment Elevation Myocardial Infarction (STEMI).....	2
Calls For Regionalization of Emergency Medical Systems of Care.....	6
American Heart Association’s <i>Mission: Lifeline</i>	6
Defining the Ideal System of STEMI Care and Its Component Parts	7
State Flex Program Role In Developing Regional STEMI Systems of Care.....	10
Conclusion	17
Key Resources.....	19
References.....	20
Table 1. Barriers To Timely Reperfusion	5
Table 2: <i>Mission: Lifeline</i> Ideal System of STEMI Care	9
Appendix A. Opportunities for State Flex Program Involvement In Supporting STEMI Systems of Care.....	24
Appendix B. Evidence-Based Regional STEMI Programs.....	25
Acronyms and Abbreviations Used In This Report	43

This Briefing paper discusses the evidence base for the development of regional systems of care for patients presenting with ST-segment elevation myocardial infarction (STEMI) and can serve as a tool for State Flex Programs in the development of these local and regional systems of care. Special emphasis is given to the role of Critical Access Hospitals (CAHs) and Emergency Medical Services (EMS) providers. This work is part of a series of Flex Monitoring Team briefs whose purpose is to identify and assess evidence-based interventions for use by State Flex Programs, CAHs, and EMS units.

This briefing paper describes the evidence supporting the development of regional systems of STEMI care and includes examples that include CAHs, other rural hospitals, and rural EMS agencies. As these initiatives have both a quality improvement and a systems development focus, they provide a valuable opportunity for State Flex Programs to engage CAHs and EMS agencies in rationalizing and improving the delivery of STEMI care to rural residents.¹⁻² This paper discusses the vital role that rural EMS agencies and CAHs can play in regional systems of STEMI care and highlights the work of four State Flex Programs in this area. It provides a resource to State Flex Programs interested in developing interventions to engage rural EMS agencies, CAHs, and other rural and urban hospitals in developing regional systems of care.

MEDICARE RURAL HOSPITAL FLEXIBILITY PROGRAM CONTEXT

The Medicare Rural Hospital Flexibility Program (Flex Program), created by Congress in 1997, allows small hospitals to be licensed as Critical Access Hospitals (CAHs) and offers grants to States to help implement initiatives to strengthen the rural health care infrastructure. To participate in the Flex Grant Program, States are required to develop a rural health care plan that provides for the creation of one or more rural health networks; promotes regionalization of rural health services in the State; and improves the quality of and access to hospital and other health services for rural residents of the State.

The core activity areas of the Flex Grant Program are: 1) support for quality improvement in CAHs; 2) support for financial and operational improvement in CAHs; 3) support health system development and community engagement, including the integration of EMS into local and

regional systems of care; and 4) conversion of eligible rural hospitals into CAHs. States use Flex resources for performance management activities, training programs, needs assessments, and network building. The Flex Program is also beginning a new special project, the Medicare Beneficiary Quality Improvement Project (MBQIP) focused on Medicare Beneficiary Health Status improvement.

State Flex Programs are required to support efforts to assist CAHs in developing collaborative local or regional systems of care, addressing community needs, and/or integrating EMS in those systems of care. CAHs can only be viable by meeting the needs of their communities. State applicants' work plans must include at least one of the following objectives: 1) support CAHs, communities, rural and urban hospitals, EMS, and other community providers in developing local and/or regional systems of care and 2) support the inclusion of EMS into those systems of care that may include, but are not limited to, regional and state trauma systems.³

Previous work by the Flex Monitoring Team has identified the challenges State Flex Programs have faced in supporting the improvement and integration of EMS as well as with the development of regional systems of care. This series of briefs reviews evidence-based strategies to assist State Flex Programs in developing interventions in these important areas of Flex activity.

SCOPE OF THE PROBLEM: ST-SEGMENT ELEVATION MYOCARDIAL INFARCTION (STEMI)

ST-segment elevation myocardial infarction (STEMI) is a significant health problem in the United States. Estimates of STEMI events range from 400,000 to 500,000 per year and account for approximately 30% of patients with acute coronary syndrome.⁴⁻⁵ STEMI is a subcategory of acute coronary syndrome characterized by electrocardiogram tracings in which the ST segments that are elevated above the baseline; a completely blocked coronary artery; no blood flow to a portion of the heart; substantial risk of death or disability; and a critical need for rapid reperfusion (i.e., restoration of blood flow by re-opening the blocked artery).⁶⁻⁷

The two major ways to re-open blocked blood vessels in the heart are pharmacological reperfusion using “clot-busting” drugs (i.e., fibrinolytics or thrombolytics) and mechanical reperfusion by primary percutaneous coronary intervention (PCI) including balloon angioplasty and the placement of intracoronary stents.^{5,7-8} Primary PCI is the preferred intervention as it is more effective and carries a lower risk of bleeding than fibrinolytic therapy.⁶⁻⁷ While primary PCI is the preferred intervention, system resource constraints (i.e., 75% of U.S. acute care hospitals lack the capacity to provide primary PCI and not all PCI hospitals have the capability of providing the service on a 24/7 basis) limit timely access to this service, particularly in rural areas⁷⁻⁸. Although fibrinolytic (thrombolytic) therapies are more widely available at U.S. hospitals and are an alternative to primary PCI under appropriate situations, patients and their providers must take into account the lower level of efficacy and greater risk of bleeding.⁶⁻⁷

The American College of Cardiology (ACC)/American Heart Association (AHA) Task Force on Practice Guidelines has issued guidelines for the management of patients with STEMI organized around the chronology of the interface between the patient and the clinician to minimize the total time from the onset of STEMI symptoms to initiation of reperfusion therapy.⁵ The 2007 update to the guidelines issued the following revised recommendations for the timing and choice of reperfusion strategy:

- STEMI patients presenting to a hospital **with** PCI capability (STEMI receiving hospital) should be treated with primary PCI within 90 minutes of first medical contact (defined as EMS arrival on scene) as a system goal.
- STEMI patients presenting to a hospital **without** PCI capability (STEMI referral hospital) and who cannot be transferred to a STEMI receiving hospital and undergo PCI within 90 minutes of first medical contact should be treated with fibrinolytic therapy within 30 minutes of hospital presentation as a system goal unless fibrinolytic therapy is contraindicated.

Although primary PCI is the preferred reperfusion strategy, the ACC/AHA Task Force noted that fibrinolytic therapy remains an important option in the treatment of STEMI.⁶ This is particularly true for hospitals located in isolated rural areas where transport times, even under ideal

conditions, may preclude the receipt of primary PCI within the recommended 90 minute window. In situations where the recommended time frame for primary PCI cannot be met, fibrinolytic therapy remains a viable and appropriate treatment modality.

Time to treatment is a critical factor for STEMI patients regardless of the reperfusion therapy used.⁸ The term “time is muscle” in STEMI care is analogous to the “golden hour” in emergency and trauma care in that rapid reperfusion within recommended treatment time frames is necessary to minimize damage to the heart muscle during a STEMI event. Research has demonstrated that a significant percentage of STEMI patients are not receiving treatment in accordance with the guidelines either because they do not receive appropriate reperfusion therapy or do not receive treatment within recommended time frames.^{4,9-10} According to the American Heart Association, 30% of STEMI patients do not receive primary PCI or fibrinolytic therapy in the absence of contraindications to their use.^{2,4} Of those who receive fibrinolytic therapy, less than half are treated within the recommended door to needle time of 30 minutes or less. For STEMI patients who are ineligible for fibrinolytic therapy, 70% do not receive PCI at all. Only 40% of those receiving PCI are treated within the ACC/AHA recommended door to balloon (D2B) time of 90 minutes or less.

Noting that out-of-hospital cardiac arrest has a “dismal prognosis in many communities,” Sanders and Kern¹¹ described the treatment of cardiac arrest as “primarily a systems problem of local communities.” Similarly, treatment of STEMI is straightforward but time sensitive involving multiple entry points into the health care system. The challenge is organizing the system so that appropriate care is delivered with minimal delays as the patient moves through it, regardless of the patient’s point of entry. (See Table 1) The ACC/AHA Task Force recommends the development of local and/or regional systems of care for the treatment of STEMI that include EMS providers, STEMI receiving hospitals, and STEMI referral hospitals.⁶ The goal of these systems is to coordinate the response to and care of STEMI patients across participating providers to reduce barriers to the timely delivery of appropriate reperfusion care in order to minimize total ischemic time. As part of the 2009 focused update of its guidelines for the management of STEMI patients, the ACC/AHA Task Force recommended that each county

develop a STEMI system of care that follows standards at least as stringent as those developed for AHA’s *Mission: Lifeline* Program.¹² The guidelines include:

- Ongoing multi-disciplinary team meetings with EMS, STEMI referral hospitals, and STEMI receiving hospitals to evaluate outcomes and quality improvement data;
- A process for prehospital identification and activation;
- Destination protocols for STEMI receiving hospitals; and
- Transfer protocols for patients who arrive at STEMI referral hospitals who are primary PCI candidates, are ineligible for fibrinolytic drugs, and/or are in cardiogenic shock.

TABLE 1. BARRIERS TO TIMELY REPERFUSION

<i>Patient behavior</i>
<ul style="list-style-type: none"> • Failure to recognize symptoms of heart attack • Reluctance to seek medical attention (STEMI patients average two hours of symptoms before arriving at the hospital.) • Failure to call 9-1-1- for transport (50% drive themselves or have someone else drive them to the ED.)
<i>Time to transport</i>
<ul style="list-style-type: none"> • Local policies requiring EMS services to transport a patient to the nearest hospital, regardless of its PCI-capabilities • Travel times from remote rural areas that preclude access to PCI within recommend time frames
<i>Decision on reperfusion strategy at STEMI referral hospitals</i>
<ul style="list-style-type: none"> • Delays in diagnosing STEMI and determining appropriate course of treatment (i.e., transfer to a STEMI receiving hospital or administer fibrinolytics) • Waiting until a formal diagnosis of STEMI is made before activating EMS for transport
<i>Time to implement treatment strategy at STEMI receiving hospitals</i>
<ul style="list-style-type: none"> • Transport to STEMI receiving hospitals that do not have 24/7 cath lab capacity • Delays in the intake system • Failure to activate cath lab before patient’s arrival • Waiting for the cardiac catheterization team to assemble and mobilize resource • Multiple, simultaneous STEMI cases overwhelm existing PCI resources

Source: AHA. *Mission:Lifeline*⁷

CALLS FOR REGIONALIZATION OF EMERGENCY MEDICAL SYSTEMS OF CARE

The Institute of Medicine (IOM) has had a long standing interest in the delivery of emergency care in the United States.⁸ In a series of reports on the future of emergency care published in June, 2006, the IOM identified a wide range of issues confronting emergency care systems including emergency department (ED) crowding, boarding of patients in ED hallways, diversion of ambulances due to lack of capacity, shortages of on-call specialty care coverage, and financial challenges.⁸ In describing these problems, the IOM's Committee on the Future of Emergency Care noted that the problems are exacerbated by a fragmented delivery system and a lack of clear lines of responsibility for oversight and policymaking. To address this issue, the 2006 reports called for the development of a "regionalized, coordinated, and accountable system of emergency care." In January 2009, the Emergency Care Coordination Center (ECCC) was established within the Department of Health and Human Services to lead federal efforts to strengthen the emergency care system. ECCC sponsored three IOM workshops to examine the US emergency care system between May and September 2009. The results of the third workshop, which focused on emergency care regionalization, were summarized in the IOM's 2010 document *Future of Emergency Care: Regionalizing Emergency Care*. Participants in the workshops examined models of regionalized care for time sensitive conditions including stroke, out-of-hospital cardiac arrest, STEMI, and care for critically ill and injured children.

AMERICAN HEART ASSOCIATION'S *MISSION: LIFELINE*

Mission: Lifeline grew out of AHA's ongoing work to improve the quality of care for acute myocardial infarction (MI) patients and increase the number of STEMI patients with timely access to primary PCI.⁷ Since 2004, AHA has worked with an advisory group of cardiology experts and stakeholders involved in the recognition, transport, and treatment of STEMI patients to develop consensus statements and recommendations for the treatment of STEMI.

The goal of *Mission: Lifeline* is to encourage collaboration and coordination between the component parts of the STEMI care system (i.e., patients and care givers; EMS providers; physicians, nurses, and others; and STEMI referral and receiving hospitals) to rationalize the use of available resources and minimize delays to timely reperfusion. With this goal in mind, the

American Heart Association has defined an “ideal capacity” for each component of the system along with a broad set of guidelines and system recommendations that can be adapted to the unique and specific needs of individual communities. Most importantly for rural hospitals, the guidelines specifically recognize and preserve a role for the STEMI referral hospital in the overall system of care.

An important part of creating a functional STEMI system of care involves development of standardized protocols for each point of entry (POE) into the system. *Mission: Lifeline* recommends that standardized POE protocols be developed by regional or State-based workgroups of EMS personnel; emergency physicians and nurses; and cardiologists with the support and involvement of third party payers. These protocols should direct where STEMI patients will be transported within the system based on specific criteria for risk, contraindications to fibrinolysis, and proximity of the nearest primary PCI service. Protocols should be developed for the EMS system (activated by a 9-1-1 call) as well as for STEMI referral and receiving hospitals.

Developing standardized STEMI protocols is not an easy task as it is complicated by the economic realities of cardiac care. STEMI systems differ from trauma and other systems of care in that STEMI care, unlike trauma care, is a profitable revenue source for many medical-surgical hospitals.⁸ For STEMI referral hospitals, the goal is to avoid diverting patients to STEMI receiving hospitals when not medically necessary. For STEMI receiving hospitals, it is necessary to be aware of overlapping service areas – areas in which these hospitals are likely to compete aggressively for patients. The development of transport protocols must be sensitive to these economic issues.

DEFINING THE IDEAL SYSTEM OF STEMI CARE AND ITS COMPONENT PARTS

Although *Mission: Lifeline* recognizes that STEMI systems of care need to be tailored to the specific needs and challenges of individual locales, it also recognizes that the individual components should possess basic characteristics and capacities for the system to function optimally.¹³ Using *Mission: Lifeline*'s ideal system components as a framework, STEMI providers, policymakers, and stakeholders can work together to build an ideal system of STEMI care for their region (Table 2).

TABLE 2: MISSION: LIFELINE IDEAL SYSTEM OF STEMI CARE

Level of Care	Characteristics and Capacities
EMS	<ul style="list-style-type: none"> • All ambulances are equipped with 12 lead ECGs • EMS personnel trained to: <ul style="list-style-type: none"> ○ Use and transmit twelve lead ECGs ○ Care for STEMI patients ○ Provide feedback on EMS and STEMI system performance ○ Comply with STEMI guidelines for care ○ Adhere to standardized POE protocols allowing for activation of the cardiac catheterization (cath) lab upon recognition of STEMI • Communication gaps with hospitals and cath labs are closed • EMS personnel remain on site (at the STEMI referral hospital) with the patient on a stretcher pending a transport decision • EMS services agree to be activated when a walk-in STEMI patient presents at STEMI referral hospital
STEMI Referral Hospital	<ul style="list-style-type: none"> • Adheres to standardized transport protocols based on criteria for risk, contraindication for fibrinolysis, and proximity to PCI services • Uses standardized triage/transfer protocols • Treats patients in accordance with ACC/AHA guidelines • Transfers to STEMI receiving hospitals using reperfusion checklists, standardized pharmacological regimens/order sets, and clinical pathways • Engages in data collection activities; rapidly and efficiently transfers data • Provides system feedback • Establishes plans for return of patient to the community after PCI
STEMI Receiving Hospital	<ul style="list-style-type: none"> • 24/7 PCI capability • Accepts prehospital ECG diagnosis, ED notification, and cath lab activation using standard, established algorithms (allows for direct transport from field to cath lab) • Establishes a single call process allowing referral hospitals to activate the cath lab • Develops written collaboration protocols with referral hospitals • Establishes a multidisciplinary team (with representatives from EMS and referral hospitals) that meets regularly • Provides for ongoing continuing education • Monitors system performance, process measures, and patient outcomes.

Source: AHA. *Ideal STEMI System*.¹³

STATE FLEX PROGRAM ROLE IN DEVELOPING REGIONAL STEMI SYSTEMS

Engaging Policymakers and Statewide Coalitions of STEMI Providers

South Carolina: Representatives from South Carolina's Office of Rural Health (SCORH)/Flex Program are ongoing members of the South Carolina *Mission: Lifeline* EMS Advisory Committee. Recently, they were also invited to participate as members of the initiative's overall Steering Committee. South Carolina's *Mission: Lifeline* is a collaborative partnership of key cardiac and STEMI care stakeholders including EMS agencies, STEMI receiving hospitals and STEMI referral hospitals. Its primary strategic goals are to:

- Create regional systems in the Midlands, Pee Dee, Upstate, and Low Country areas;
- Establish one-call cath lab activation systems;
- Establish a unified statewide data management system for tracking and analyzing key acute cardiac care indicators;
- Establish common clinical performance goals and standards;
- Provide a system for active learning and knowledge sharing;
- Implement a unified public awareness campaign; and
- Provide jointly sponsored educational programs.

Key components of South Carolina *Mission: Lifeline* include the:

- Steering Committee which meets bimonthly to provide direction to the initiative;
- Alliance which includes approximately 100 members from all partner organizations;
- EMS Advisory Committee which meets quarterly;
- South Carolina Hospital Association/*Mission: Lifeline* Annual STEMI Educational Forum; and
- Regional Directors hired by the systems to support STEMI activities in each region.

South Carolina's Flex Program funds SCORH/Flex Program participation on the EMS Advisory and *Mission: Lifeline* Steering Committees. SCORH/Flex's role on the EMS Advisory

Committee is to provide input on rural EMS issues and development of measures relevant to rural EMS providers. Its role on the Steering Committee is to represent the interests of CAHs and other rural hospitals. The overarching goal is to reduce D2B times to meet established state standards for STEMI patients originating from rural communities.

To date, *Mission: Lifeline's* focus has been on working with large STEMI receiving hospitals. Within the last three to six months, however, its focus has shifted to STEMI referral hospitals and their role in reducing time to reperfusion. As such, SCORH/Flex Program participation on the Steering Committee brings an important rural focus to the table.

Rural EMS providers have been well represented in the discussions of STEMI systems of care and a number of regional STEMI systems have hired EMS coordinators to support EMS participation and address their educational needs. Recently, South Carolina's Flex Program has begun to explore the creation of rural relevant STEMI measures as well as ways to link EMS data available through the Prehospital Medical Information System (PreMIS) with hospital data from the Acute Coronary Treatment and Intervention Outcome Network (ACTION) registry.

Facilitating the Development of Local/Regional Coalitions and Supporting EMS Training

Illinois: With Flex Program funding, the Illinois Critical Access Hospital Network (ICAHN) supports participation of CAHs and rural EMS units in regional STEMI systems of care based on ACC/AHA *Mission: Lifeline* guidelines. ICAHN's efforts are currently focused in downstate Illinois to capitalize on the resources provided by three well established hospital networks. ICAHN's STEMI activities include:

- Preparing and supporting CAHs to serve as STEMI referral hospitals by developing and implementing standardized treatment protocols, standing orders, clinical pathways, and transport protocols;
- Encouraging development of data collection and quality improvement systems to allow multidisciplinary STEMI teams, including EMS, to review hospital-specific STEMI data on a quarterly basis;

- Working with EMS regional coordinators and teams to support development and implementation of standardized treatment algorithms for evaluating and treating STEMI patients, transport protocols, and standardized reperfusion pathways;
- Implementing processes to monitor care provided to EMS patients with STEMI;
- Conducting a needs assessment in partnership with Southern Illinois University to identify existing STEMI systems, describe what hospitals and EMS agencies are doing now, identify gaps in systems of care, and estimate EMS equipment needs to bring them up to ACC/AHA standards;
- Supporting collaboration by attending downstate STEMI committee meetings; attending EMS Advisory Council quarterly meetings, establishing relationships with EMS regional STEMI teams, establishing a collaborative relationship with ACC/AHA's *Mission: Lifeline* team, and creating a monthly newsletter to share information with hospitals and partners;
- Organizing professional education resources including webinars on STEMI systems of care, workshops on ECG interpretation, capnography, stethoscopy, and other topics, an on-line STEMI resource library, quarterly STEMI discussion groups, and STEMI programs at ICAHN conferences; and
- Developing community awareness programs for use by hospitals and collaborating with AHA to use their public service announcements and marketing materials.

An important part of ICAHN's STEMI activities is their consultant's work in encouraging and facilitating development of local/regional STEMI workgroups involving STEMI referral and receiving hospitals, EMS, air transport services, physicians, and other providers. The consultant also disseminates information and updates to hospitals, EMS units and other stakeholders participating in the development of STEMI systems of care.

According to the consultant, engaging EMS units, providing them with equipment to conduct and transmit 12 lead ECGs, and assisting them in developing transport plans are among the more difficult challenges in developing STEMI systems of care. The difficulties faced by rural EMS agencies (e.g., a heavy reliance on volunteer staff, winter weather conditions, long travel distances, and limited transport capacity including EMS agencies with only one ambulance

serving rural communities) require out of the box thinking. Although ICAHN's networks of CAHs can be a valuable resource in developing STEMI systems of care, local EMS agencies must be involved in the discussion as the implementation often affects them (EMS) more than hospitals. EMS agencies frequently need technical assistance and direction to support their participation.

According to the consultant, training EMS staff in rural areas where comparatively few STEMI cases are seen can be particularly challenging. In more heavily populated areas with a greater volume of STEMI cases, EMS providers can be trained to administer and interpret 12 lead ECGs and, as part of their protocols, activate the cath lab. In rural areas, this may not always be possible as EMS providers may not see enough cases to maintain their proficiency in interpreting ECGs. The outcome is likely to be too many false positives resulting in unnecessary activation of regional cath labs. In these situations, the consultant recommends that EMS personnel transmit the ECGs to the hospital where the hospital emergency department staff are responsible for interpretation and cath lab activation. The consultant also noted that hospital resources can complicate transport decisions, particularly for patients that have been started on fibrinolytics. In rural areas, a nurse may not be available to accompany and monitor these patients during transport to a PCI receiving hospital. These issues must be worked out at the local/regional level.

ICAHN's consultant noted that collaboration typically requires a new mindset as rural EMS units vary in their organization and capacity and suggested bringing key players together on a region by region basis to establish regional STEMI committees. A facilitator can play an important role by helping committee members focus on patient care and avoid political issues. Politically, it may be useful to use a facilitator that is neither from the area or one of the participants in the process. Strong committee leadership is crucial to the success of the process.

The consultant explained that each of the five STEMI regions in Illinois are sufficiently different, in terms of resources, travel distances, and 9-1-1 capacity, to require individualized approaches to developing STEMI systems of care. As such, it is necessary to look at the entire system when targeting resources and technical assistance to support these providers.

The consultant raised one additional very important issue for CAHs and other rural STEMI referral hospitals participating in these systems of care. Given that transport protocols are likely to by-pass these hospitals, an important system consideration is a process to return STEMI patients to the local community for follow-up care and cardiac rehab. Guidelines to encourage the return of patients to their home communities and engage local hospitals in their follow up care can be an important incentive to persuade STEMI referral hospitals to agree to standardized bypass protocols and engage as active members of STEMI systems of care.

Development of STEMI Systems of Care Involving CAHs

Washington State: Washington State's Rural Healthcare Quality Network (RHQN) has undertaken an ongoing acute myocardial infarction (AMI)/STEMI initiative with funding from Washington's Flex Program. RHQN plays an important role in supporting Washington's CAHs as 30 of the State's 34 CAHs are independent, free standing facilities and not affiliated with a larger hospital system. RHQN is working with its members, urban STEMI receiving hospitals, and EMS agencies to develop and implement statewide standardized AMI/STEMI transfer protocols. As a result of its efforts, more patients are making it from the rural emergency room door to cath lab balloon in 90 minutes or less.

RHQN's AMI/STEMI initiative operates within the context of Washington's June 10, 2010 legislation, Second Substitute House Bill (SHB) 2396, which created multi-level emergency cardiac and stroke systems of care consistent with Washington's existing multi-level trauma system.¹⁴ SHB 2396 called for the Department of Health (DOH) to encourage hospitals to voluntarily self-identify which level of cardiac services the facility provides. The hospital levels are defined by prior work (dating back to 2006) of DOH and its Emergency Cardiac and Stroke (ECS) Work Group and published in its September 2008 report on Emergency Cardiac and Stroke Care in Washington.¹⁴ DOH has established a two level cardiac care system. Level 1 cardiac centers are STEMI receiving hospitals with an ability to provide primary PCI on a 24/7 basis. Level 2 cardiac centers (i.e., STEMI referral hospitals) provide rapid assessment and treatment of acute coronary symptoms through transfer to a Level 1 center or treatment with fibrinolytics, depending on transport times and regional system arrangements. In addition to

establishing criteria for each of the two levels of care, SHB 2396 requires participating hospitals to engage in ongoing regional quality improvement programs.

RHQN's work on AMI/STEMI preceded the 2010 legislation with its 2008 quality improvement project focused on heart attack and stroke care and continues with its efforts to assist CAHs in making the ECS system work in their communities.

This work receives ongoing funding from Washington State's Flex Program and includes:

- Developing AMI/STEMI standardized protocols, standing orders, data collection tools, and educational materials for use by CAHs (available on the RHQN website);
- Providing technical assistance and support to CAHs;
- Disseminating information on best practices for AMI/STEMI care;
- Working with DOH, the ECS Work Group, and the American College of Cardiology to develop protocols and standards for the two levels of cardiac centers;
- Working with individual CAHs, STEMI receiving hospitals, and EMS units to implement Cardiac Level One Care protocols;
- Assisting CAHs with data collection and analysis;
- Convening and facilitating ongoing regional meetings between CAHs, STEMI receiving hospitals, and EMS services to implement emergency cardiac and stroke systems of care;
- Convening and facilitating three annual AMI/STEMI statewide conferences focusing on pre-hospital, rural hospital and urban STEMI receiving hospital care issues; and
- Publishing ongoing quality newsletters for Washington's CAHs.

RHQN was recognized by the Agency for Healthcare Research and Quality for its work in developing and implementing the Cardiac Level One Care Protocols at Lincoln Hospital in Davenport and across the state.¹⁵ Currently, all 34 Washington CAHs have adopted the statewide AMI transfer protocols.¹⁶ RHQN reports significant improvement in outcomes and patient safety as a result of the implementation of the AMI/STEMI protocols.¹⁶ During a one year period (third quarter, 2009 to third quarter 2010), the average door to transport time in CAHs declined from 197 to 100 minutes. Door to ECG times also improved as the percentage of AMI patients

receiving an ECG within twelve minutes of arrival in the rural ED increased from 62% in the third quarter 2009 to slightly over 81% in the third quarter of 2010.

Michigan: Spectrum Health Reed City Hospital (Reed City) is a 25-bed CAH that has undertaken a STEMI performance improvement challenge. Located in the west central portion of Michigan's Lower Peninsula, Reed City is roughly equidistant from Grand Rapids and Traverse City. The hospital is part of the Spectrum Health System which includes the Meijer Heart Center located approximately 70 miles to the south in Grand Rapids. Of the eight referral hospitals in the Spectrum Health STEMI Network (SHSN), Reed City is located furthest from Meijer Heart Center, Spectrum's STEMI receiving hospital. Travel time from Reed City to Meijer is approximately 70 minutes by ground and 25 minutes by air.

Reed City undertook the STEMI performance improvement challenge in early 2009 under the instigation and leadership of its emergency department staff. Reed City assembled a multidisciplinary team that included emergency department, administrative, and other clinical staff from Reed City; EMS personnel and medical control directors from the two local EMS agencies; physician and nursing staff from Meijer Heart Center; the medical director and manager of clinical flight operations for Aeromed, a helicopter transport service, and the Director of SHSN. Barriers to achieving 1st D2B times of 90 minutes included a lack of 12 lead ECG capability in one of the EMS agencies, long travel distances, weather conditions that impact travel times, and delays in notifying and mobilizing Aeromed's services. Prior to its STEMI performance improvement initiative, Reed City's 1st D2B time averaged approximately 120 minutes.

Reed City's STEMI team developed and implemented the following changes:

- An AMI bag containing necessary drugs, IV fluids, and supplies was created to centralize everything needed to initiate AMI/STEMI treatment in one place;
- All emergency department staff were trained to perform 12 lead ECGs;
- A standardized order set to evaluate and treat AMI/STEMI patients was implemented;
- County commissioners committed funds to equip all ambulances with 12 lead ECGs;
- Reed City provided 12 lead ECG interpretation classes for all paramedics;

- Aeromed and cath lab activation was enabled based on prehospital 12 lead ECGs;
- Alternative helicopter rendezvous sites were established based on paramedic input;
- A nurse and physician now meet EMS on hospital grounds prior to rendezvous with Aeromed;
- The nurse brings an AMI bag to the landing pad and administers medications as ordered by the physician; and
- All hospital and EMS staff have been educated on the new STEMI protocols.

As result of the STEMI performance improvement challenge, 1st D2B times and total time in the emergency department have dropped for patients arriving by EMS or walking through the emergency department door. Prior to the implementing the above changes, STEMI patients arriving by ambulance at Reed City had an average D2B time of 120 minutes. Following implementation, three STEMI patients arriving by ambulance at Reed City in one week had D2B times of 56, 59, and 60 minutes respectively.¹⁷

Through the Michigan Critical Access Hospital Quality Network (MICAHQN), which is funded by Michigan's Flex Program, formal presentations and education sessions have been provided to the 36 CAH network members. The Flex Program has also featured the efforts of Reed City along with the STEMI Initiative of Northern Lower Michigan in Traverse City in its CAH and MICAHQN newsletters so that other CAHs can learn from their efforts.

CONCLUSION

There is an extensive body of evidence supporting the development of regional systems of STEMI care, including studies that include both rural STEMI referral hospitals and/or rural STEMI receiving hospitals. As these initiatives have both a quality improvement and a systems development focus, they provide a valuable opportunity for State Flex Programs to engage CAHs and EMS agencies in rationalizing and improving the delivery of care to rural STEMI patients.¹⁻² In particular, the evidence identifies a vital role for EMS in regional systems of STEMI care (i.e., conducting and interpreting prehospital ECGs, prehospital activation of cath labs, and implementing point of entry and transport protocols). This provides an opportunity for State Flex

Programs to directly engage EMS units in working with their local CAHs as well as other rural and urban hospitals in their areas. (See Appendix A)

The examples of State Flex Program activities supporting the development of STEMI systems of care described in this policy brief suggest a number of options for Flex Program engagement.

The first involves participation in statewide STEMI committees such as South Carolina's *Mission: Lifeline* project which focuses on developing statewide standards for STEMI care and encouraging the implementation of those standards and systems of care in rural communities.

The second involves working with EMS units, CAHs, and other hospitals at the local level to improve system capacity and coordination of care. Examples of Flex Program activity in this area include the provision of training to EMS units on the use and interpretation of 12 lead ECGs (Illinois), support for the development of regional systems of STEMI care (Washington); dissemination of information on these systems of care to other hospitals (Michigan); and formation of committees to address deficiencies in the provision of STEMI care and facilitation of discussions between the participants (i.e., CAHs, STEMI receiving hospitals, other hospitals, and EMS units) in developing targeted system improvements (Illinois).

The State examples described in this policy brief and the related resources links provide additional information that can be used by State Flex Programs in the development of interventions to improve the delivery of STEMI care in rural areas.

KEY RESOURCES

Mission: Lifeline

http://www.heart.org/HEARTORG/HealthcareResearch/MissionLifelineHomePage/Mission-Lifeline-Home-Page_UCM_305495_SubHomePage.jsp

Door to Balloon Alliance: Sustain the Gain

<http://www.d2balliance.org/>

Reperfusion of Acute Myocardial Infarction in Carolina Emergency Departments (RACE)

<http://www.nccacc.org/news/news1.html>

***Project Upstart: Excellence in R2R Quality Improvement Program
(University of Virginia Department of Emergency Medicine)***

<http://www.projectupstart.com/index.php>

***AHA Conference Proceedings:
Development of Systems of Care for ST-Elevation
Myocardial Infarction Patients***

<http://circ.ahajournals.org/content/116/2/e29.full>

Act in Time Educational Resources

<http://www.nhlbi.nih.gov/actintime/>

REFERENCES

1. Butterly JR. Quality Improvement in the Interventional Treatment of Acute Myocardial Infarction: 5 Health Care Systems and Their Innovative Solutions to Regional Challenges. *Prog Cardiovasc Dis*. 2010 Nov-Dec; 53:181-2.
2. Jacobs AK. Regional Systems of Care for Patients With ST-Elevation Myocardial Infarction: Being at the Right Place at the Right Time. *Circulation*. 2007 Aug 14; 116:689-92.
3. Office of Rural Health Policy (ORHP). *Medicare Rural Hospital Flexibility Grant Program: Funding Opportunity Announcement, Fiscal Year 2010*. (HRSA-10-049). Rockville, MD: U.S. Department of Health and Human Services, Health Resources and Services Administration, Office of Rural Health Policy; January 2010.
4. Rosamond W, Flegal K, Friday G, et al. Heart Disease and Stroke Statistics--2007 Update: a Report From the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. *Circulation*. 2007 Feb 6; 115:e69-171.
5. Antman EM, Anbe DT, Armstrong PW, et al. ACC/AHA Guidelines for the Management of Patients With ST-Elevation Myocardial Infarction--Executive Summary: a Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 1999 Guidelines for the Management of Patients With Acute Myocardial Infarction). *Circulation*. 2004 Aug 3; 110:588-636.
6. Antman EM, Hand M, Armstrong PW, et al. 2007 Focused Update of the ACC/AHA 2004 Guidelines for the Management of Patients With ST-Elevation Myocardial Infarction: a Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *J Am Coll Cardiol*. 2008 Jan 15; 51:210-47.
7. American Heart Association. *Mission: Lifeline*. [Web Page]. 2011. Available at: http://www.heart.org/HEARTORG/HealthcareProfessional/Mission-Lifeline-HomePage_UCM_305495_SubHomePage.jsp. Accessed May 18, 2011.
8. Institute of Medicine (IOM). *Regionalizing Emergency Care: Workshop Summary*. Washington, DC: National Academies Press; 2010.
9. Faxon DP. Development of Systems of Care for ST-Elevation Myocardial Infarction Patients: Current State of ST-Elevation Myocardial Infarction Care. *Circulation*. 2007 Jul 10; 116:e29-32.
10. Fox KA. An International Perspective on Acute Coronary Syndrome Care: Insights From the Global Registry of Acute Coronary Events. *Am Heart J*. 2004 Nov; 148:S40-5.

11. Sanders AB, Kern KB. Surviving Cardiac Arrest: Location, Location, Location. *JAMA*. 2008 Sep 24; 300:1462-3.
12. Kushner FG, Hand M, Smith SC Jr, et al. 2009 Focused Updates: ACC/AHA Guidelines for the Management of Patients With ST-Elevation Myocardial Infarction (Updating the 2004 Guideline and 2007 Focused Update) and ACC/AHA/SCAI Guidelines on Percutaneous Coronary Intervention (Updating the 2005 Guideline and 2007 Focused Update): a Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Circulation*. 2009 Dec 1; 120:2271-306.
13. American Heart Association. *Ideal STEMI-System*. [Web Page]. 2011. Available at: http://www.heart.org/HEARTORG/HealthcareResearch/MissionLifelineHomePage/STEMISystems/Ideal-STEMI-System_UCM_313655_Article.jsp. Accessed May 18, 2011.
14. Washington State Department of Health. *Emergency Cardiac and Stroke Care in Washington*. Olympia, WA: Department of Health; September 2008.
15. Rural Healthcare Quality Network. RHQN Recognized for Cardiac Care Level One Protocol Work. *RHQN Newsletter*. 2009, April. http://www.rhqn.org/news/RHQN_2009_04.pdf
16. Rural Healthcare Quality Network. Good News on AMI Care in Rural Washington State. *RHQN Newsletter*. 2011, February. http://www.rhqn.org/news/RHQN_2011_02.pdf
17. Michigan Center for Rural Health. STEMI Performance Improvement Challenge. *Rural EMS Quarterly*. 2010, September;1-2. <http://www.mcrh.msu.edu/documents/ems/September.pdf>
18. Ting HH, Rihal CS, Gersh BJ, et al. Regional Systems of Care to Optimize Timeliness of Reperfusion Therapy for ST-Elevation Myocardial Infarction: the Mayo Clinic STEMI Protocol. *Circulation*. 2007 Aug 14; 116:729-36.
19. Henry TD, Sharkey SW, Burke MN, et al. A Regional System to Provide Timely Access to Percutaneous Coronary Intervention for ST-Elevation Myocardial Infarction. *Circulation*. 2007 Aug 14; 116:721-8.
20. Aguirre FV, Varghese JJ, Kelley MP, et al. Rural Interhospital Transfer of ST-Elevation Myocardial Infarction Patients for Percutaneous Coronary Revascularization: the Stat Heart Program. *Circulation*. 2008 Mar 4 ; 117:1145-52.
21. Jollis JG, Roettig ML, Aluko AO, et al. Implementation of a Statewide System for Coronary Reperfusion for ST-Segment Elevation Myocardial Infarction. *JAMA*. 2007 Nov 28; 298:2371-80.
22. Krumholz HM, Bradley EH, Nallamothu BK, et al. A Campaign to Improve the Timeliness of Primary Percutaneous Coronary Intervention: Door-to-Balloon: An Alliance for Quality. *JACC Cardiovasc Interv*. 2008 Feb; 1:97-104.

23. Niles NW, Conley SM, Yang RC, et al. Primary Percutaneous Coronary Intervention for Patients Presenting With ST-Segment Elevation Myocardial Infarction: Process Improvement in a Rural ST-Segment Elevation Myocardial Infarction Receiving Center. *Prog Cardiovasc Dis.* 2010 Nov-Dec; 53:202-9.
24. Rezaee ME, Conley SM, Anderson TA, et al. Primary Percutaneous Coronary Intervention for Patients Presenting With ST-Elevation Myocardial Infarction: Process Improvements in Rural Prehospital Care Delivered by Emergency Medical Services . *Prog Cardiovasc Dis.* 2010 Nov-Dec; 53:210-8.
25. Ting HH, Krumholz HM, Bradley EH, et al. Implementation and Integration of Prehospital ECGs into Systems of Care for Acute Coronary Syndrome: a Scientific Statement From the American Heart Association Interdisciplinary Council on Quality of Care and Outcomes Research, Emergency Cardiovascular Care Committee, Council on Cardiovascular Nursing, and Council on Clinical Cardiology. *Circulation.* 2008 Sep 2; 118:1066-79.
26. Diercks DB, Kontos MC, Chen AY, et al. Utilization and Impact of Pre-Hospital Electrocardiograms for Patients With Acute ST-Segment Elevation Myocardial Infarction: Data From the NCDR (National Cardiovascular Data Registry) ACTION (Acute Coronary Treatment and Intervention Outcomes Network) Registry. *J Am Coll Cardiol.* 2009 Jan 13; 53:161-6.
27. Singer AJ, Shembekar A, Visram F, et al. Emergency Department Activation of an Interventional Cardiology Team Reduces Door-to-Balloon Times in ST-Segment-Elevation Myocardial Infarction. *Ann Emerg Med.* 2007 Nov; 50:538-44.
28. Rokos IC, French WJ, Koenig WJ, et al. Integration of Pre-Hospital Electrocardiograms and ST-Elevation Myocardial Infarction Receiving Center (SRC) Networks: Impact on Door-to-Balloon Times Across 10 Independent Regions. *JACC Cardiovasc Interv.* 2009 Apr; 2:339-46.
29. Blankenship JC, Scott TD, Skelding KA, et al. Door-to-Balloon Times Under 90 Min Can Be Routinely Achieved for Patients Transferred for ST-Segment Elevation Myocardial Infarction Percutaneous Coronary Intervention in a Rural Setting. *J Am Coll Cardiol.* 2011 Jan 18; 57:272-9.
30. Blankenship JC, Haldis TA, Wood GC, et al. Rapid Triage and Transport of Patients With ST-Elevation Myocardial Infarction for Percutaneous Coronary Intervention in a Rural Health System. *Am J Cardiol.* 2007 Sep 15; 100:944-8.
31. Millin MG, Brooks SC, Travers A, et al. Emergency Medical Services Management of ST-Elevation Myocardial Infarction. *Prehosp Emerg Care.* 2008 Jul-Sep; 12:395-403.
32. Le May MR, Dionne R, Maloney J, Poirier P. The Role of Paramedics in a Primary PCI Program for ST-Elevation Myocardial Infarction. *Prog Cardiovasc Dis.* 2010 Nov-Dec; 53:183-7.

33. Studnek JR, Garvey L, Blackwell T, Vandeventer S, Ward SR. Association Between Prehospital Time Intervals and ST-Elevation Myocardial Infarction System Performance. *Circulation*. 2010 Oct 12; 122:1464-9.
34. Pitta SR, Myers LA, Bjerke CM, White RD, Ting HH. Using Prehospital Electrocardiograms to Improve Door-to-Balloon Time for Transferred Patients With ST-Elevation Myocardial Infarction: a Case of Extreme Performance. *Circ Cardiovasc Qual Outcomes*. 2010 Jan; 3:93-7.
35. Wang TY, Nallamothu BK, Krumholz HM, et al. Association of Door-in to Door-Out Time With Reperfusion Delays and Outcomes Among Patients Transferred for Primary Percutaneous Coronary Intervention. *JAMA*. 2011 Jun 22; 305:2540-7.

APPENDIX A. OPPORTUNITIES FOR STATE FLEX PROGRAM INVOLVEMENT IN SUPPORTING STEMI SYSTEMS OF CARE

<ul style="list-style-type: none">● Participation in statewide STEMI committee<ul style="list-style-type: none">○ South Carolina’s participation in the South Carolina <i>Mission: Lifeline</i> project
<ul style="list-style-type: none">● Working with EMS units, CAHs, and other hospitals at the local level to improve system capacity and coordination of care<ul style="list-style-type: none">○ Illinois’s provision of training on the use and interpretation of 12 lead ECGs
<ul style="list-style-type: none">● Support for the development of regional systems of STEMI care<ul style="list-style-type: none">○ Washington’s support for the RHQN STEMI program
<ul style="list-style-type: none">● Formation of local committees to address deficiencies in the provision of STEMI care and facilitation of discussions between the participants<ul style="list-style-type: none">○ Illinois’s technical assistance and facilitation support for developing targeted STEMI systems improvements
<ul style="list-style-type: none">● Disseminating information on successful STEMI initiatives involving CAHs<ul style="list-style-type: none">○ Michigan’s role in disseminating information on successful STEMI initiatives through newsletters and network/conference presentation

APPENDIX B. EVIDENCE-BASED REGIONAL STEMI PROGRAMS

Sponsoring Organizations	Program Description	Results	Inclusion of CAHs/ small rural hospitals	Citations
Division of Cardiovascular Diseases, Mayo Clinic	The study evaluates Mayo Clinic’s protocol to optimize timeliness of reperfusion and coordinate systems of care for a STEMI receiving hospital and 28 regional STEMI referral hospitals located up to 150 miles away across three states. The study followed 597 patients who presented with STEMI within 12 hours of symptom onset to St. Mary’s Hospital (the receiving hospital) or one of the regional referral hospitals between May 2004 and December 2006	Seventy five percent of patients that presented at St. Mary’s (Group A) were treated with PCI within the recommended D2B time of less than 90 minutes. Twelve percent of patients presenting at one of the regional referral hospitals and later transferred to St. Mary’s for PCI (Group B) were treated within the recommended 90 minute window. For patients presenting at a regional referral hospital and receiving fibrinolysis (Group C), 70% received fibrinolytic therapy within the recommended 30 minute window. Median symptom onset to treatment time for each group was 188, 278, and 103 minutes respectively. The use of the Mayo Clinic STEMI protocols allowed the system to achieve treatment times that were close to or better than recommended guidelines for STEMI patients in a large, diverse geographic area.	Yes	Ting et al., 2007. ¹⁸

Sponsoring Organizations	Program Description	Results	Inclusion of CAHs/ small rural hospitals	Citations
Minneapolis Heart Institute at Abbott Northwestern Hospital	The study evaluated the use of a standardized PCI-based STEMI treatment system for patients from 30 STEMI referral hospitals located up to 210 miles from Abbott Northwestern Hospital (STEMI receiving hospital). This study analyzed data from 1345 STEMI patients including 1048 transferred from STEMI referral hospitals in the system from March 2003 to November 2006.	Median first D2B times for patients presenting at the Abbott Northwestern; Zone 1 hospitals (under 60 miles from the receiving center); and Zone 2 hospitals (60-210 miles from the receiving center) were 65, 95, and 120 minutes respectively. Median total symptom to balloon times were 171, 203, and 214 minutes respectively. Rapid transfer of STEMI patients from STEMI referral hospitals up to 210 miles from the STEMI receiving hospital is safe and effective using a standardized protocol with an integrated transfer system and achieves outcomes that were similar to patients that presented directly to the STEMI receiving hospital.	Yes	Henry et al., 2007. ¹⁹
Prairie Cardiovascular Consultants; Department of Internal Medicine and Division of Cardiology, Department of Medicine,	The study involved 230 presumed STEMI patients who underwent interhospital transfer between six STEMI-referral and two STEMI-receiving hospitals in rural central Illinois from January 2005 through March 2007. Transfers were conducted using standardized treatment protocols and rapid interhospital transfer for	Median door 1–to-departure time was 46 minutes with roughly 2/3rds of the delay attributable to a wait for transport arrival and departure. Median transport and door 2–to-balloon times were 29 minutes and 35 minutes respectively. Median total door 1–to-balloon time was 117 minutes. Approximately 12% and	Yes	Aguirre et al., 2008. ²⁰

Sponsoring Organizations	Program Description	Results	Inclusion of CAHs/ small rural hospitals	Citations
Southern Illinois University School of Medicine; Prairie Education and Research Cooperative; and Prairie Care Alliance	primary PCI or rescue PCI after full-dose intravenous fibrinolysis was initiated by the emergency department physician. The study tracked three times to evaluate system performance: STEMI referral care (door 1 to departure); transport time (door 1 departure to STEMI receiving hospital arrival [door 2]); and STEMI receiving hospital care (door 2 to balloon).	58% of patients were treated with a door 1 to balloon time of 90 and 120 minutes respectively. The study demonstrates the feasibility and generalizability of implementing a STEMI program utilizing standardized, port-of-entry triage and treatment protocols based on established STEMI algorithms. The study demonstrates that the program can be implemented safely in rural communities and deliver timely primary or rescue PCI.		
Duke Clinical Research Institute, Duke University Medical Center	<p>This study explored the impact of a statewide system (RACE - Reperfusion of Acute Myocardial Infarction in Carolina Emergency Departments) for coronary reperfusion on changes in the speed and rate of coronary reperfusion in North Carolina after its implementation in 2006. RACE focused on coordination of each aspect of care from the first emergency medical contact to reperfusion and reduction in the time required for each component.</p> <p>The study used data from 1164 patients</p>	Median reperfusion times improved significantly for first door to device in STEMI receiving hospitals following the intervention (85 to 74 minutes) as did transfers to STEMI receiving hospitals (165 to 128 minutes), door to needle in STEMI referral hospitals (35 to 29 minutes), and door-in to door-out for patients transferred from STEMI referral hospitals (120 to 71 minutes). Clinical outcomes such as death, cardiac arrest, and cardiogenic shock did not significantly change following implementation.	Yes	Jollis et al., 2007. ²¹

Sponsoring Organizations	Program Description	Results	Inclusion of CAHs/ small rural hospitals	Citations
	with STEMI including 579 pre-intervention (during the months July 1, 2005 and September 30, 2005) and 585 post-intervention (during the months January 1, 2007 and March 31, 2007).	The implementation of RACE significantly improved quality of care and suggests that more resources should be applied to EMS and EDs to treat STEMI (as has occurred in trauma systems in the US.)		
Yale University School of Medicine	This study describes Door-to-Balloon (D2B): An Alliance for Quality. D2B was organized by ACC in partnership with AHA and 37 other organizations to quickly translate research about how to reduce and maintain recommended D2B times for patients with STEMI. D2B was developed to implement the ACC/AHA guidelines that STEMI receiving hospitals perform PCI in 90 minutes. Phase 1 (planning) involved development of core processes by an evidence-based workgroup that would be promoted by D2B. Phase 2 (implementation) included a drive for participation with more than 1000 hospitals enrolling in D2B. Phase 3 (intervention) involved development and dissemination of tools and information to implement the D2B	D2B strategies: <ol style="list-style-type: none"> 1. Activation of cath lab by emergency medicine physicians; 2. A single-call system for activating the cath lab; 3. Cath lab team available within 20-30 minutes of being paged; 4. Data monitoring and prompt feedback to ED and cath lab staff; 5. Senior management support and organizational environment to foster/sustain organizational change to improve D2B time; 6. Team-base approach within a culture of continuous quality improvement; and 	Unknown	Krumholz et al., 2008. ²²

Sponsoring Organizations	Program Description	Results	Inclusion of CAHs/ small rural hospitals	Citations
	recommendations.	<p>7. Use of prehospital ECG to activate the cath lab (optional).</p> <p>D2B has been successful in uniting a broad-based coalition of practitioners, hospitals, and organizations to work together to improve D2B times.</p>		
Dartmouth-Hitchcock Medical Center	<p>A rural STEMI receiving hospital implemented evidence-based strategies to reduce time to ECG and D2B. Strategies included cath lab activation triggered by a prehospital ECG or diagnosis by an emergency department physician; single call cath lab activation; cath lab response times of 30 minutes or less; by-pass protocols for five STEMI referral hospitals within a 45 minute drive time; and prompt data feedback. Data were collected using Dartmouth-Hitchcock's registry of patients presenting with STEMI between January 2006 and October 2009.</p> <p>The authors analyzed data for two groups of patients - Group 1 (presenting before May 1, 2008 and the</p>	<p>Reductions in time intervals to treatment were reported for the patients in Group 2 compared to patients in Group 1. Median D2B time for Group 2 was 67 minutes compared to 108 for Group 1. Median door to ECG time for Group 2 was 7 minutes compared to 14 minutes for Group 1. The percentage of patients receiving primary PCI within the recommended 90 minute window increased from 36% to 77%. No differences in the rates of death, recurrent infarction, stroke, or major hemorrhage were reported between the two groups. Cath lab activation and false STEMI were found to be infrequent and consistent with results from prior single-center registry studies. The study suggests that additional time reductions might</p>	Yes	Niles et al., 2010. ²³

Sponsoring Organizations	Program Description	Results	Inclusion of CAHs/ small rural hospitals	Citations
	implementation of the STEMI strategies) and Group 2 (presenting on/after May 1, 2008 and the implementation of the STEMI strategies).	be achieved with implementation of prehospital cath lab activation, single call cath lab activation, prompt data feedback, and EMS destination protocols.		
Dartmouth-Hitchcock Medical Center	This study looked at process improvements in rural prehospital/EMS STEMI care. The study used data on 177 patients who received primary PCI at Dartmouth-Hitchcock Medical Center from January 2006 to October 2009. The hospital implemented a STEMI continuous quality improvement project known as “STEP-UP” on May 1 st 2008. The cohort was divided into two groups representing pre and post-intervention time periods. STEP-UP included interventions to improve D2B time and a redesign of the hospital’s STEMI prehospital triage network (i.e., implementation of prehospital ECGs, prehospital cath lab activation, destination protocols for local emergency department bypass, and individual EMS provider- specific feedback for every patient transported to Dartmouth-Hitchcock.	Improvements in first medical contact to balloon time of 30 minutes were reported (from 145.1 minutes pre-intervention to 115.2 minutes post intervention). Frequency of STEMI referral hospital bypass increased from 27% of cases to 44%; frequency of prehospital ECGs increased from 49% to 80% of cases; and frequency of prehospital cath lab activations increased from 4% to 32%. EMS dispatch to scene time remained roughly the same and EMS time on scene decreased from 18 to 16.2 minutes. This study demonstrated the ability of a rural STEMI receiving hospital to work alongside resource-limited EMS providers to improve regional prehospital STEMI care. Eighty percent of cases received a	Yes	Rezaee et al., 2010. ²⁴

Sponsoring Organizations	Program Description	Results	Inclusion of CAHs/ small rural hospitals	Citations
		<p>prehospital ECG (post-intervention) yet only 32% of cases resulted in prehospital cath lab activation. Increasing the percentage of prehospital cath lab activations represents an opportunity for further reductions in first medical contact to balloon times.</p> <p>Using data on the time intervals for each component of the STEMI care process, the authors calculated maximum potential transport times (43-46 minutes) for the system to achieve the 90 minute window for first medical contact to balloon times and to identify opportunities for further improvement.</p>		
<p>American Heart Association Interdisciplinary Council on Quality of Care and Outcomes Research, Emergency Cardiovascular</p>	<p>This document is an American Heart Association Scientific Statement on the implementation and integration of prehospital ECGs into systems of care for acute coronary syndrome. It acknowledges that prehospital ECGs are not used as often as they should be. It also acknowledges that even when prehospital ECGs are used, the</p>	<p>The evidence demonstrates that:</p> <ol style="list-style-type: none"> 1. EMS providers with specific ECG training can reliably interpret prehospital ECGs without transmitting to a hospital or physicians; 2. Wireless transmission of prehospital ECGs is feasible; 	<p>Not applicable</p>	<p>Ting et al., 2008.²⁵</p>

Sponsoring Organizations	Program Description	Results	Inclusion of CAHs/ small rural hospitals	Citations
Care Committee, and Council on Cardiovascular Nursing, and Council on Clinical Cardiology	information is often not effectively translated into action and coordinated with hospital systems of care. This paper summarizes the evidence regarding prehospital ECGs, reviews barriers to routine use, and recommends approaches to enhance their use and effectiveness in STEMI systems of care.	<p>3. EMS and hospitals can effectively organize systems to use prehospital ECGs; and</p> <p>4. Regional networks of hospitals can organize systems to effectively use prehospital ECGs.</p> <p>Identified barriers to use of prehospital ECG:</p> <ol style="list-style-type: none"> 1. Lack of cost-effectiveness models to evaluate this technology from the perspectives of patients, hospitals, payers, and society; 2. Lack of capacity across EMS units; 3. Difficulty of providing training and maintaining competency of EMS across diverse EMS systems; 4. Failure of patients with chest pain to use EMS (less than 50% of patients with chest pain use EMS) thereby limiting their access to 		

Sponsoring Organizations	Program Description	Results	Inclusion of CAHs/ small rural hospitals	Citations
		<p>prehospital ECGs;</p> <ol style="list-style-type: none"> 5. Lack of collaboration across EMS agencies, emergency departments, hospital systems, providers, and cardiologists; 6. Regional hospital networks focus on maximizing market share rather than ideal patient care; and 7. Poor/inconsistent reimbursement. <p>The authors conclude that these barriers can be overcome with dedicated efforts.</p>		
<p>University of California Davis Medical Center, Virginia Commonwealth University Health System, Duke Clinical Research Institute, etc.</p>	<p>This study analyzed the association between prehospital ECGs and the timing of reperfusion strategies for STEMI patients. Data came from the NCDR (National Cardiovascular Data Registry) ACTION (Acute Coronary Treatment and Intervention Outcomes Network) registry for 7,098 patients with chest pain who were transported by EMS during the period January 1, 2007 through December 31, 2007. Of this group, 1,941 received a prehospital</p>	<p>For patients with prehospital ECGs compared those in-hospital ECGs:</p> <ol style="list-style-type: none"> 1. 92.1% and 86.3% respectively received PCI; 2. 4.6% and 4.2% received fibrinolytic therapy; 3. Median door to needle times for fibrinolytic treatment was 19 and 29 minutes respectively; 4. Median D2B time for PCI was 	<p>Not specified</p>	<p>Diercks et al., 2009.²⁶</p>

Sponsoring Organizations	Program Description	Results	Inclusion of CAHs/ small rural hospitals	Citations
	ECG.	<p>61 and 75 minutes respectively.</p> <p>Only 25% of patients received a prehospital ECG.</p> <p>The use of prehospital ECGs for chest pain patients is associated with a greater use of reperfusion therapy, faster reperfusion times, and a trend for a lower adjusted-risk of in-hospital mortality. The study supports a greater use of prehospital ECGs as a key triage tool for chest pain patients who are first evaluated by EMS.</p>		
Stony Brook University Departments of Emergency Medicine and Cardiology	This study reported on suburban academic emergency department's implementation of protocols (Code H) calling for immediate bedside activation of members of the interventional cardiology team for all ED patients presenting with STEMI. The study compared D2B times for 43 patients treated in the two years prior to implementation of Code H and 54 patients treated in the two years following the implementation of Code	The percentage of patients undergoing PCI within 90 minutes increased from 2.8% pre-implementation to 29% post-implementation. Median D2B times dropped from 176 to 108 minutes. For the 48 STEMI patients treated more than two years after implementation of Code H, median D2B time decreased by an additional 20 minutes (to 88 minutes) and the percentage of patients receiving PCI within 90 minutes increased to 52%.	No	Singer et al., 2007. ²⁷

Sponsoring Organizations	Program Description	Results	Inclusion of CAHs/ small rural hospitals	Citations
	H as well as data for an additional 48 STEMI patients who were treated in 2006 (more than two years past the implementation of Code H).	The study demonstrated the benefits of the Code H intervention in reducing D2B times and the percentage of patients undergoing PCI within 90 minutes.		
UCLA-Olive View Medical Center; Los Angeles County EMS, Orange County Health Care Agency, and others.	This study is based on a pooled analysis of data from 10 independent, prospective, observational registries maintained by 10 STEMI receiving hospital networks. The networks represented 72 hospitals. The study was based on data for 2,712 patients with a prehospital ECG diagnosis of STEMI who were transported directly to the nearest STEMI receiving hospital. Of this group, 2,053 underwent PCI.	<p>Eighty six percent of patients receiving PCI did so within the recommended D2B time of 90 minutes. The authors acknowledged that this relatively high rate is likely due to the fact that the study does not include self-transported STEMI patients (who often experience reperfusion delays due to emergency department overcrowding).</p> <p>The study demonstrates that prehospital ECGs can be successfully integrated into STEMI systems of care thereby allowing for immediate transport and early activation of cath labs.</p>	Yes	Rokos et al., 2009. ²⁸
Department of Cardiology, Geisinger Medical	In 2005, Geisinger Medical Center implemented a program for rapid triage, transfer, and treatment of STEMI	The study reported a decrease in the median D2B time of 101 minutes during the five year study period with	Yes	Blankenship et al., 2011. ²⁹

Sponsoring Organizations	Program Description	Results	Inclusion of CAHs/ small rural hospitals	Citations
Center	<p>patients. Additional improvements to the program were implemented in 2006 and 2007.</p> <p>The study is based on data from 676 patients with 687 STEMIs transferred to the STEMI receiving hospital during the period January 1, 2004 through December 31, 2008. The STEMI rapid triage and transfer protocols encouraged STEMI referral hospital emergency physicians to call the STEMI receiving hospital emergency department directly. After reviewing faxed copies of the ECG and screening the patient with a 9 question checklist, the STEMI receiving hospital emergency department physicians dispatch a helicopter and alert the interventional cardiologist. The cath lab team is alerted and typically meets the patient and helicopter crew at the doors of the cath lab suite. (During the study, few local ambulances had 12 lead ECG capabilities. Helicopter transport was generally preferred by community emergency room physicians and used in 83% of transports.)</p>	<p>75% of the decrease occurring in the first year. Sixty six percent of the decrease was attributed to efficiencies at the STEMI receiving hospital and 34% to efficiencies in systems of care before the patient reached the STEMI receiving hospital. The percentage of patients treated within the recommended window for D2B time increased from 1% in 2004 to 53% in 2008.</p> <p>The authors noted that their results were achieved without fully implementing the type of formal, rigid systems advocated by others. Formal transfer agreements were not signed between the STEMI referral and receiving hospitals and there were no administrative relationships between the hospitals. Referral as made using a 1-call-for-transfer program offered to the emergency department physicians at the STEMI referral hospitals.</p>		Blankenship et al., 2007. ³⁰

Sponsoring Organizations	Program Description	Results	Inclusion of CAHs/ small rural hospitals	Citations
.Department of Emergency Medicine, John Hopkins University School of Medicine	<p>This paper summarizes the position of the National Association of EMS Physicians (NAEMSP) on the role of EMS in the management of STEMI patients and the development of cardiovascular systems of care. NAEMSP believes that advanced life support EMS providers should have the education, training, equipment, and protocols to facilitate early recognition and the prehospital care of patients with STEMI.</p>	<p>EMS plays a critical role in the early identification and prehospital treatment of STEMI. The following interventions were identified to support the role of EMS in STEMI systems of care:</p> <ol style="list-style-type: none"> 1. Implementation of prehospital ECGs; 2. Use of standard therapies including cardiac monitoring, establishing peripheral intravenous access, oxygen, aspirin, nitroglycerin, and opiates; 3. Administration of prehospital fibrinolytics (when appropriate and not contraindicated); 4. Prehospital triage and activation of the cath lab; 5. Establishment of a quality assurance and improvement program for prehospital STEMI care; and 6. Integration of the EMS system with community and regional cardiac systems of care. 	Not applicable	Millin et al, 2008. ³¹

Sponsoring Organizations	Program Description	Results	Inclusion of CAHs/ small rural hospitals	Citations
Ottawa Heart Institute	The study examined the evidence supporting the role of paramedics in STEMI systems of care using data from 1573 STEMI patients referred to the Ottawa Heart Institute between July 2004 and May 2009.	<p>Median D2B times remained significantly lower over the course of the study for patients transferred from the field via the paramedic referred pathway compared to patients transferred from emergency departments. Patients transferred via paramedic referred pathways had lower in-hospital mortality rates (3.2%) compared to those transferred from hospital emergency departments (5.7%).</p> <p>The study supports an expanded role for paramedics to triage and refer patients for primary PCI.</p>	No	Le May et al., 2010. ³²
East Carolina Medical Center and Mecklenburg EMS Agency	This study examines whether prehospital time intervals are associated with STEMI system performance (defined as first medical contact to PCI). Study data came from a county registry of prehospital STEMI activations maintained by the Mecklenburg EMS Agency between March 2007 and March 2009 and included 165 patients for whom complete system time intervals were available. As the	<p>The study described prehospital system time intervals and developed five theoretical benchmarks for prehospital activities necessary to achieve the 90 minute window for PCI. These five activities and related benchmarks were associated highly with achieving the overall standard of 90 minutes:</p> <ol style="list-style-type: none"> 1. Response time of 11 minutes 	Unknown	Studnek et al., 2010. ³³

Sponsoring Organizations	Program Description	Results	Inclusion of CAHs/ small rural hospitals	Citations
	<p>ACC/AHA modified its system treatment windows in 2007 to reflect the time of first medical contact (defined as EMS arrival on the scene) for both primary PCI and fibrinolytic therapy, this study sought to understand the association between prehospital activities and the achievement of the ACC/AHA guidelines for treatment.</p>	<p>or less;</p> <ol style="list-style-type: none"> 2. Time to obtain a 12 lead ECG of 8 minutes or less; 3. Total on-scene time of 15 minutes or less; 4. Time to notify the hospital of STEMI of 10 minutes or less; and 5. Time to transport patients off scene and arrive on the cath lab table of 30 minutes or less. <p>Time to cath lab table, scene time, and response time were the three variables most significantly associated with achieving the desired system outcomes.</p>		
<p>Mayo Clinic, Division of Cardiovascular Diseases</p>	<p>This study examines the implementation of a prehospital ECG program at a 77 bed rural community hospital in February 2009. The hospital was 50 miles from the STEMI receiving hospital. The program included:</p> <ol style="list-style-type: none"> 1. Training EMS personnel to acquire and interpret prehospital ECGs; 	<p>Although data following the implementation of the program was very limited, the authors noted that the potential for a prehospital ECG program to improve outcomes in patients with STEMI depends on how well the program is integrated with downstream systems of care for urban and rural networks of STEMI referral and receiving hospitals. They make</p>	<p>Yes</p>	<p>Pitta et al., 2010.³⁴</p>

Sponsoring Organizations	Program Description	Results	Inclusion of CAHs/ small rural hospitals	Citations
	<ol style="list-style-type: none"> 2. Implementing a protocol to guide the decision to acquire a prehospital ECG; 3. Implementing a process for EMS personnel to activate a STEMI protocol that includes autolaunching helicopter transport and alerting the cath lab team at the STEMI receiving hospital; 4. Implementing diversion protocol to identify when it was appropriate to bypass the STEMI referral hospital and when it was not; 5. Developing a process to minimize the door in and out time for the STEMI referral hospital; and 6. Developing a process to provide immediate feedback to all clinical providers. <p>Following implementation of the program, the authors analyzed data for 60 patients that received prehospital ECGs collected from February to</p>	<p>the point that a “rural hybrid system” will require unique models for paramedics to coordinate prehospital triage and integrate helicopter autolaunch and intercept at the STEMI referral hospital or en route. The authors planned to extend this rural hybrid system of prehospital triage and helicopter intercept to 30 STEMI referral hospital located in rural Minnesota, Iowa, and Wisconsin and to conduct an evaluation of the program that will focus on pre- and post-comparisons of process and outcome measures.</p>		

Sponsoring Organizations	Program Description	Results	Inclusion of CAHs/ small rural hospitals	Citations
	August 2009. Only one was diagnosed with STEMI; the remaining 59 were categorized as not STEMI.			
Duke University Medical Center	Using data from 14,281 STEMI patients transferred to 298 STEMI receiving hospitals between January 2007 and March 2010 (ACTION Registry), this study examined characteristics related to door-in to door-out (DIDO) times of 30 minutes or less (the benchmark established in 2008 by the ACC/AHA Guidelines). A DIDO time of 30 minutes or less is significantly more likely to have a D2B time of 90 minutes or less compared to those with a DIDO time of greater than 30 minutes.	<p>Median DIDO time was 68 minutes and only 11% of patients had DIDO times that met the standard of less than 30 minutes. Off-hours presentations and non-EMS transport were significantly associated with DIDO times of 30 minutes or more, suggesting opportunities to improve the process of STEMI care in STEMI referral hospitals. The study identified other controllable hospital and system level variables (such as a focus on early triage, treatment on the stretcher, a pre-specified simple reperfusion strategy coordinated with the STEMI receiving hospital, use of prehospital ECGs, and activating transport with earlier lead times) that are associated with reduced DIDO times.</p> <p>The study found a significantly higher mortality risk associated with DIDO time greater than 30 minutes. The authors suggest that further attention</p>	Unknown	Wang et al., 2011. ³⁵

Sponsoring Organizations	Program Description	Results	Inclusion of CAHs/ small rural hospitals	Citations
		to improving DIDO times will contribute to substantial improvement in the timeliness of PCI and in clinical outcomes for transferred STEMI patients.		

ACRONYMS AND ABBREVIATIONS USED IN THIS REPORT

ACC: American College of Cardiology (ACC)

Action registry: Acute Coronary Treatment and Intervention Outcome Network registry

AHA: American Heart Association

AMI: Acute myocardial infarction

CAHs: Critical Access Hospitals

Cath labs: Cardiac catheterization labs

D2B: Door to balloon

DIDO: Door in; Door out

DOH: Washington's Department of Health

ECG: Electrocardiograms

ECS: Washington DOH's Emergency Cardiac and Stroke Work Group

ED: Emergency Department

EMS: Emergency Medical Services

ECCC: Emergency Care Coordination Center (ECCC)

Flex Program: Medicare Rural Medicare Rural Hospital Flexibility Program

ICAHN: Illinois Critical Access Hospital Network

IOM: Institute of Medicine

IV: Intravenous

MBQIP: Medicare Beneficiary Quality Improvement Project

MICAHQN: Michigan Critical Access Hospital Quality Network

NAEMSP: National Association of EMS Physicians

NCDR: National Cardiovascular Data Registry

PCI: Primary percutaneous coronary intervention

POE: Point of entry

PreMIS: Prehospital Medical Information System (PreMIS)

Prehospital ECGs: ECGs conducted by EMS providers prior to arrival at a STEMI referral or receiving hospital

RACE: Reperfusion of Acute Myocardial Infarction in Carolina Emergency Departments

RHQ: Washington's Rural Healthcare Quality Network

SCORH: South Carolina's Office of Rural Health

SHSN: Spectrum Health STEMI Network

STEMI: ST-segment elevation myocardial infarction

STEMI receiving hospitals: Hospitals with PCI capability

STEMI referral hospitals: Hospitals without PCI capability

STEP-UP: ST-Elevation Myocardial Infarction Process Upgrade Project