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# *START the STEMI Clock*

Early discovery & electronic ECG transmission shorten time to treatment



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JOURNAL OF EMERGENCY MEDICAL SERVICES

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A supplement to June 2008 *JEMS*  
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sense and simplicity

# Start the STEMI Clock

A supplement to June 2008 *JEMS*, sponsored by Philips Healthcare

## The Value of Trending

The nice thing about a focused supplement is that it presents a high dose of current trends, research and technology and keeps you up to date on advances in the ever-changing world of medicine. Notice that I did not say *prehospital* care or EMS. That was deliberate, because this supplement, sponsored by Philips Healthcare, truly exhibits the importance of how your service fits into the entire spectrum of patient care.

This supplement addresses the need for your system to be involved—from the pre-incident education of your citizens to the first 9-1-1 calltaker who recognizes the caller's cardiac incident—in the rapid prehospital intervention of monitoring, defibrillation, drug therapy and, now, hypothermic resuscitation of your codes.

More important, it illustrates the value of watching for, and alerting hospital teams to, trends you see in the field. The availability of on-screen trending of your patient's vital sign parameters is a big deal. Simply by glancing at the Philips HeartStart MRx display, you can see changes in all of your patient's vital signs and better assess and treat problems. That's why Philips Healthcare chose to deliver the message about data trending, transmission and other important concepts in this highly educational format.

—A.J. Heightman, MPA, EMT-P  
Editor-in-Chief, *JEMS*

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# Discovery to Treatment

## Time is muscle for STEMI patients

Time is such a critical element for the survival of patients suffering an acute myocardial infarction that it's essential for all of the key players to know their roles and take immediate and appropriate action. It all came together one day in Charlottesville, Va., for a 47-year-old man with chest pain.

First, the patient called 9-1-1 within 30 minutes of the onset of chest pain, says William Brady, MD, professor of emergency medicine at the University of Virginia, in Charlottesville. Brady is also the medical director for Charlottesville-Albemarle Rescue, a third-service EMS provider in the area. A fire company with the City of Charlottesville Fire Department was the first on scene and began providing basic life support. Paramedics with Charlottesville-Albemarle Rescue arrived soon after.

The patient was pale, diaphoretic and anxious, with a blood pressure of 80 mmHg systolic. He was complaining of crushing substernal chest pain radiating to his left arm. He was nauseous and experiencing some shortness of breath. The paramedics started an IV line with a normal saline fluid bolus, gave him oxygen and aspirin and placed him on a monitor. According to Brady, the electrocardiogram (ECG)

conducted in the back of the unit on the way to the hospital took less than three minutes to perform. It clearly showed an ST-segment elevation myocardial infarction (STEMI) that would likely require reperfusion therapy.

Per their protocols, the paramedics transmitted the ECG to the emergency department (ED). The doctor there activated the "STEMI Alert" process, preparing the ED for the patient's arrival, notifying the cardiologist and assembling the catheterization lab (cath lab) team—much like the Trauma Alert system response for patients with severe traumatic injuries.

The patient arrived in the ED less than 12 minutes later with a BP of approximately 100 mmHg systolic. He was assessed by the STEMI team and, within six minutes, transferred to the cath lab for a percutaneous coronary intervention (PCI). During PCI, a complete obstruction to flow was noted in the proximal right coronary artery and a stent was successfully placed in the proximal and mid right coronary artery. Acute inferior wall STEMI with right ventricular infarction was confirmed in the cath lab. From the initial 9-1-1 call to the time the patient arrived in the cath lab was approximately 30 minutes.



EMS must be integrated into an overall initiative to reduce door-to-balloon times. Evaluating patient data and watching for trends in vital signs have become important aspects of an ALS provider's responsibilities.

PHOTO: TERESA MCCALLION

“It’s safe to say that prehospital ECG diagnosis of STEMI reduces door-to-therapy time in the STEMI patient,” Brady says. He also notes that this time reduction is true for both fibrinolysis and PCI. By starting at the point of discovery, hospital staff can use the transport time to prepare for the patient’s arrival, significantly reducing door-to-balloon times. Brady estimates Charlottesville’s STEMI Alert System reduces time to therapy by 30 to 45 minutes at the University of Virginia.

The biggest challenge, says Brady, is that during reasonably short transport times, some prehospital providers don’t see the advantage of conducting and transmitting the ECG in the field. But Brady is adamant. The ability to diagnose STEMI prior to arrival provides the ED and cardiology staff the opportunity to prioritize patient management.

### Case study: Discovery-to-therapy time line

Onset of chest pain to 9-1-1 call: 30 minutes  
 On-scene time for fire and EMS: 9 minutes  
 ECG: 2.44 minutes  
 Transport time to ED: 12 minutes  
 ED to arrival at cath lab: 6 minutes  
*Total time from onset of pain to balloon = less than 1 hour*

On average, says Brady, it takes three minutes to capture and transmit an ECG in the field. This pre-arrival identification of the patient with STEMI allows the hospital to focus its effort on rapid diagnosis and definitive management of the acute infarction—thereby significantly reducing the time-to-therapy. “Three minutes spent in the prehospital setting reduces infarct time by 30 minutes,” Brady says. “It’s time well spent.”

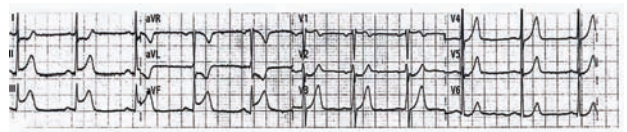
### New role for EMS

Few in the medical community would disagree that patients with acute STEMI require reperfusion therapy or that a door-to-balloon time of less than 90 minutes is optimal. However, even the most recent research suggests that few hospitals meet the time requirement for most of their STEMI patients.

Deciding on a strategy for improving those times may require a major paradigm shift, says Ivan C. Rokos, MD, FAAP, assistant clinical professor at Geffen School of Medicine at UCLA. According to Rokos, time is the most important therapeutic variable for patients suffering a STEMI. Improvements to in-hospital care of the cardiac patient have resulted in crucial minutes saved, and a significant gain—often 15 minutes or more—can be made while the patient is still in the care of prehospital providers.

“I really think there’s a new role for EMS,” Rokos said at the 2008 National Association of Emergency Medical Service Physicians Annual Meeting in Phoenix. “EMS holds the key to improved door-to-balloon time.”

Rokos’ presentation, “EMS and STEMI: The Evolution of a Major Paradigm Shift,” recommended integrating



The ECG conducted on the way to the hospital showed a STEMI that would likely require reperfusion therapy.

EMS into a regional network of STEMI Receiving Center hospitals and empowering EMS crews to conduct cardiac triage, transmit vital prehospital ECGs from the field and activate the cardiac catheterization laboratory.

Studies have shown that as many as one-third of STEMI patients don’t receive any reperfusion therapy, in part because they’re at one of the 75% of hospitals in the U.S. that does *not* perform primary PCI.<sup>1</sup> Even among cardiac care facilities, few cath labs are staffed 24 hours a day, seven days a week. The American Heart Association suggests that if just half of those patients were able to undergo primary PCI, an estimated 2,640 lives would be saved annually.<sup>2</sup> Using the current trauma system as an example, Rokos describes how designated STEMI Receiving Centers would work. The sickest patients are identified in the field by paramedics and triaged to a facility that is best capable of providing the specialized care needed. In this parallel process, the cardiologist and the patient are heading to the hospital at the same time.

Using this model, Rokos believes STEMI Receiving Center Networks have the potential to “time-terminate” STEMIs.<sup>3</sup>

*‘EMS holds the key to improved door-to-balloon time.’ —Ivan C. Rokos, MD*

Because STEMI patients also arrive at hospitals by personal vehicle, an interhospital transfer protocol also needs to be developed in conjunction with the EMS track.

### Overcoming obstacles

Early identification of a STEMI and the speedy activation of the hospital’s cardiac cath lab dramatically reduce wait time for patients who need reperfusion therapy. Yet, despite compelling clinical studies, many 12-lead transmission programs have floundered. The primary culprits are technical hurdles and a lack of cooperation between the medical community and EMS.

To help hospitals overcome these obstacles, the American College of Cardiology has spearheaded D2B: An Alliance for Quality ([www.d2balliance.org](http://www.d2balliance.org)). It advocates the adoption of six key, evidence-based strategies for reducing door-to-balloon times. They are:

1. ED physician activation of the cath lab;
2. One-call activation of the cath lab;
3. Cath lab team ready in 20–30 minutes;
4. Prompt data feedback;
5. Senior management commitment; and
6. A team-based approach.



The quicker a STEMI is recognized and the patient transferred to a cath lab, the better the patient's chances are for a positive outcome.

In the study, "Strategies for reducing the door-to-balloon time in acute myocardial infarction," led by Elizabeth H. Bradley, PhD, professor of public health at the Yale School of Public Health,<sup>4</sup> researchers found that having ED physicians activate the cath lab without consulting a cardiologist provided an 8.2-minute reduction in door-to-balloon time. Activating the cath lab while the patient was still en route, based on a prehospital ECG, saved 15.4 minutes.

The study also noted that false activations were rare when either ED physicians or EMS crews activated the lab.

### False cath lab activations

Although activating the cardiac cath lab early has proven to reduce discovery-to-balloon times in patients with STEMI, the move has not been without detractors. Some hospitals are concerned that allowing the ED physician or EMS personnel in the field to activate the cath lab leads to a disproportionate number of expensive false activations. In addition to the inconvenience, some believe the cost of frequent false activations could derail the program.

A recent study by David M. Larson, MD, of the Minneapolis Heart Institute Foundation at Abbott Northwestern Hospital, Minneapolis, et al, "'False-positive' cardiac catheterization laboratory activation among patients with suspected ST-segment elevation myocardial infarction," found that the prevalence of false activations for inter-hospital transfers is between 9.2 and 14%, depending on the definition.<sup>5</sup>

Although the consequences of the false positive activations must be considered, one should not lose sight of the benefit of early definitive treatment for the remaining 85–91%.

### New technology

One company providing both prehospital and hospital providers with innovative technologies is Philips Healthcare. Because the company supplies equipment to departments throughout the hospital, it is able to "think of the bigger information picture," says Brendan Shea, product manager for ALS data management solutions at Philips Healthcare.

ECGs in the field acquired via Philips monitor/defibrillators

can be sent simultaneously to multiple locations at the receiving hospital, including the diagnostic cardiology database that's available to nurses at the bedside for baseline comparison after the patient is admitted. "Often, EMS agencies that don't transmit their 12-leads will tell you that their transport times are too short or that the hospital trusts the medic's call," says Shea. "But it's important to note that transmission is about more than corroborating a diagnosis. It's about starting the information chain with the presenting rhythm and having it all end up in the patient chart."

Field transmissions can be as simple as a photo of an ECG strip taken by a camera phone or as technical as digital wireless packet data technology. An off-the-shelf cell phone, mobile phone or personal data assistant (PDA) with no special modifications is often used to transmit the data, and broadband routers are gaining in popularity with larger ambulance services.

Some STEMI alert programs are now facing challenges related to the requirement for cell phone carriers to switch from analog signals to the new Internet-based technology, making 12-lead transmission problematic. Systems using the Philips HeartStart MRx don't have that problem. Since it was introduced, the MRx has transmitted ECGs via the Internet.

*'We've been really impressed with the quality of the 12-leads sent via cell phone, particularly in the most rural areas of our county.'* —Mike D'Haene, EMT-P, Granville County EMS, Oxford, N.C.

In addition to 800-MHz radio transmission, Bluetooth technology on the MRx allows the 12-lead report to be transmitted wirelessly to a cell phone, then to the hospital via the Internet. Typically, the signal travels by way of cellular towers, landlines or wireless Internet connections, which are quickly becoming the mode of choice.

"We've been really impressed with the quality of the 12-leads sent via cell phone, particularly in the most rural areas of our county," says Mike D'Haene, EMT-P, captain and training officer for Granville County EMS, Oxford, N.C. "Even with a half bar on the phone, the tracings received at the hospital are beautiful."

At the hospital, transmissions are received by the Philips 12-Lead Transfer Station and automatically sent to as many destinations as required, including a dedicated fax machine in the ED, a network printer or an e-mail address. In some cases, the ECG is forwarded to the cardiology department's ECG database, such as the Philips TraceMasterVue ECG Management System.

Philips' cardiology offerings span the entire continuum of cardiac care, from prehospital monitor/defibrillators to cardi-

ology databases, to cath lab systems, to bedside monitors, all of which give access to the patient 12-lead ECG. “Only Philips has the ability to go from curbside to bedside,” Shea says. “And it all works together.”

### Case study: Granville County EMS

Not quite a year ago, Granville County EMS and Granville Medical Center launched a 12-lead transmission project. The “12-Lead Implementation Team” comprised representatives from both the hospital and EMS. “The key for any EMS agency is to consult with the people who will ultimately receive the data,” says Emergency Services Director Martin Bragg, Granville County EMS. With the full support of the agency’s medical director, Bragg convinced the Board of Commissioners to spend \$126,000 on new 12-lead monitors.

“In order to be an efficient system, [we] must have the tools to make decisions on the correct method of treatment in a short amount of time,” Bragg says. After extensive field-testing, the team decided on the Philips HeartStart MRx, because of its ease of use, functionality and easy-to-read screens. “That’s important when you’ve got all this going on,” Bragg says.

To receive the transmissions, Granville County EMS purchased a fax machine for the medical center serving as the agency’s base hospital. The ECG is transmitted to a cell phone using the Bluetooth-enabled monitors. The phone sends the data via the Internet, to a transfer station (located at the dispatch center) that has been pre-programmed for 10 area hospitals. A fax of the ECG is sent to the base hospital, which then directs the crew to the proper receiving hospital. The receiving hospital is also sent a copy of the 12-lead ECG transmission.

Bragg says Philips coordinated with Granville’s internal training personnel to provide instruction on how to effectively use the monitors and recognize the various cardiac events. Granville’s medical director conducts a quarterly quality review of every cardiac call. A peer review team meets monthly.

The biggest challenge, says Bragg, has been the lack of cell phone coverage in some areas. To help alleviate the problem, Granville purchased power boosters for the cell phones to use during transport. As a backup in case of spotty cellular signal, Philips monitors can use Bluetooth technology to send the data to a land-line modem, which can then be used to dial up the Internet from a patient’s home phone line or a fax line at a business.

### Case study: Charlottesville-Albemarle Rescue

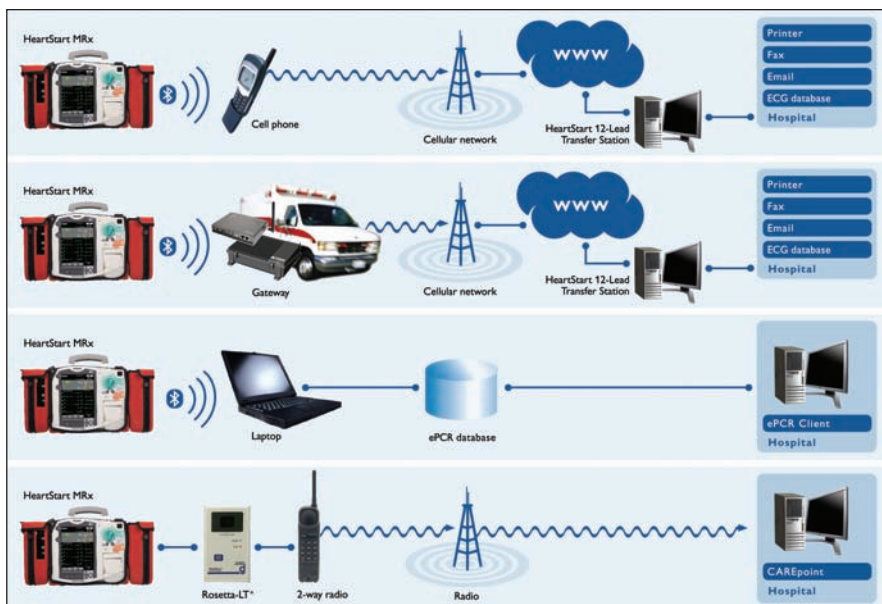
Charlottesville-Albemarle Rescue, a volunteer EMS agency, was the first large EMS agency to use the Philips HeartStart MRx and one of the first to launch a 12-lead transmission program using Philips software. Because only some of the agency’s monitors are Bluetooth capable, its procedure for sending an ECG to the ED is to use a serial cable to connect a cell phone to the monitor. The phone dials a server at the University of Virginia Medical Center ED. The server can also forward the transmission to another hospital, if necessary. Charlottesville-Albemarle Rescue donated the server to the hospital, which oversees upgrades and maintenance. Other agencies that use the Philips system can access the hospital via the same server.

Jim Miller, ALS equipment manager at Charlottesville-Albemarle, reports that cell phone coverage in the area poses a challenge. It takes approximately two minutes to send a standard 12-lead transmission. Because the monitor is designed to send all or none of an ECG, if coverage is dropped during transmission, the data are stored until a signal is available. Then sending takes one push of a button.

Although Miller says he’s backed by his medical director, getting other physicians, nurses and physician assistants to take EMS seriously when it came to STEMI patients wasn’t easy. He heard many stories of his crews arriving with a STEMI patient only to be told the patient had a “normal” ECG in the hospital. Other paramedics have reported that the ED team routinely disregards ECG strips conducted in the field. Instead, a second ECG is done in the ED after the patient has been treated with medications that sometimes temporarily normalize the previously documented cardiac condition.

### Starting the clock earlier

Rokos says adding EMS is a critical part of changing the paradigm from door-to-balloon time to discovery-to-



The Philips HeartStart MRx offers agencies a variety of transmission methods.

therapy time. He emphasizes that the clock really begins not at the door of the hospital, but when the patient first recognizes symptoms. Once EMS has been integrated into the discovery-to-therapy paradigm, the next step is to educate the public.

Some studies note the effectiveness of public awareness programs. Communities that have such programs have experienced an increase in the number of cardiac patients or their families calling 9-1-1 for an ambulance rather than driving to the hospital.<sup>6</sup> Bragg says that, although public awareness is necessary, funding is often problematic. His agency takes every opportunity it can to spread the word, including at the local senior center and health center, where EMS conducts blood pressure checks.

### Summary

Shaving precious minutes from door-to-balloon times—or, better yet, discovery-to-therapy times—has been the mission of many hospitals with cardiac cath labs. Further improvements must include both EMS and the patient. The technology is in place to integrate EMS into the cardiac team. However, it will take a team effort to raise awareness among potential cardiac patients, their families and friends and get them to start the process by calling 9-1-1. “We have created the vehicle,” Rokos says. “EMS holds the ticket to the STEMI train.” [JEMS](#)

**Teresa McCallion, EMT-B**, is a freelance public safety writer living in Bonney Lake, Wash.

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By Patricia Krapesh

## Clearing a Path to Treatment

When St. Mary’s Health Care System, Athens, Ga., launched its rapid recognition/remote ECG program in July 2005, their vision, according to David Bailey, MD, St. Mary’s director of Critical Care Medicine and Respiratory, was simple: “We wanted to try to save heart muscle by early recognition and getting the patient to the right setting for the best possible treatment. We were doing it for our community.”

St. Mary’s, which was one of the first facilities in the country to establish an EMS remote ECG program, is also certified by The Joint Commission (JCAHO) as a Heart Failure Center and a Stroke Center. St. Mary’s is not currently a cardiac interventional hospital, but has the sole remote ECG program in the area, with a metro population of about 175,000.

About eight months into the new remote ECG program, recalls Bailey, who previously served as director of St. Mary’s cardiac program, a 9-1-1 call came in from an area clinic where a 33-year-old male was presenting all the classic signs of STEMI. St. Mary’s EMS responded and acquired a 12-lead ECG that revealed a massive MI. Remote transmission of the ECG results were sent by cell phone to St. Mary’s ED and to a staff cardiologist, who promptly directed the EMS crew to take the patient to an area hospital that offered interventional services. St. Mary’s staff alerted the

destination hospital in advance and provided vital information prior to the patient’s arrival. The patient was in the ED for only about five minutes before he was rushed to the cath lab for a successful procedure. The patient recovered. Bailey says, “[This] is just one of many miraculous stories about how rapid recognition/remote ECG programs save lives.”

*‘You don’t have to have four different machines to take care of one patient,’ says David Bailey, MD. [The MRx] does it all.’*

An important consideration for St. Mary’s remote ECG program was equipment selection. The Philips HeartStart MRx was the best fit for St. Mary’s overall program needs, says Bailey, who co-chaired the selection committee, which evaluated products from five vendors before selecting the MRx. Because of the prevalence of heart, lung and respiratory diseases in the area, the committee wanted equipment that did more than just 12-leads. They wanted a broad spectrum of patient monitoring options, including end-tidal CO<sub>2</sub>, and other vitals. Commenting on the MRx, Bailey says, “You don’t have to have four different machines to take care of one patient. One instrument does it all.” [JEMS](#)



# Information Use Made Easy

## Data management plays crucial role in patient care

“When [EMS providers] arrive on the scene of a patient who’s unconscious or having severe cardiac symptoms, like chest pain, shortness of breath or poor perfusion, if we can document the reason, then that patient can get the lifesaving care they need at the hospital,” says Jim Augustine, MD, who serves on the clinical faculty in the Department of Emergency Medicine at Emory University and as medical director for the Atlanta Fire Department. “If we miss that opportunity and don’t document the rhythm, we may miss what originally caused the patient’s problem.”

Whether a patient improves or gets worse following an intervention, the EMS provider must appreciate the change in the patient’s status and be able to convey and back up that change with evidence so that health-care providers at the next level will have that history to consider as they deliver continued care.

### Real-time monitoring, data collection & transmission

EMS personnel routinely monitor heart rhythms and respiratory rates, and use noninvasive techniques to measure blood pressures, oxygen saturation, end-tidal CO<sub>2</sub> levels and temperature. And ALS monitor/defibrillators, such as the Philips HeartStart MRx, now do much more than monitor cardiac dysrhythmias. They allow for the collection and wireless transmission of more data, earlier in the patient care continuum. But what happens to all that information and how can it be used to provide better and earlier patient care?

For some agencies, the collected data goes on the EMS patient care report (PCR) that’s attached to the patient’s chart, and that’s where it stops. Other EMS systems are using that data as the basis for implementing policies and procedures designed to shorten the time between the onset

of STEMI and the delivery of treatment, most often percutaneous coronary intervention, so that parallel processing between patient transport and cath lab preparation can occur, saving precious minutes—and likely thousands more hearts and lives.

The MRx makes it easy for EMS providers to monitor vital sign trends in real time and use the information to expedite care. “We can see what’s going on so clearly with the MRx’s capabilities and trending that it’s easy to justify our transportation of the patient to the cath lab at Duke University Hospital,” says Mike D’Haene, EMT-P, captain and training officer for Granville County (N.C.) EMS.

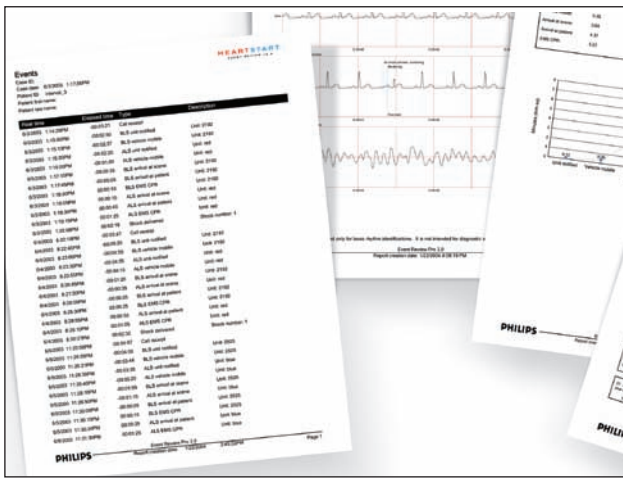
Although the MRx has defibrillation technology, it truly functions as a multi-parameter monitor with 12-lead ECG acquisition and transmission capability, combining monitoring with diagnostic measurements, vital signs trending and patented resuscitation therapies. Patient monitoring and data collection begin as soon as the patient cable is connected to the device. Monitoring is accomplished through the defibrillation pads, which provide ECG monitoring, synchronized cardioversion, noninvasive pacing and external defibrillation.

“I have been impressed with the ability to bring a true critical care monitor out in the field to the prehospital patient’s bedside,” says Jim Miller, RN, CFRN, NREMT-P, the Charlottesville-Albemarle (Va.) Rescue Squad’s ALS equipment manager.

Data collected in the field by the HeartStart MRx can be wirelessly transmitted to a 12-Lead Transfer Station in the ED via multiple methods (see diagram, p. 7). The same 12-lead information can then be immediately distributed to cardiology teams and the cath lab, creating significant time



In combination, the Philips MRx and Event Review Pro give providers the ability to view vital sign trends reports in numeric or graphic format. All critical vital signs can be trended and displayed to provide a complete picture of the patient’s condition to expedite care, determine the sequence of events and reveal the effects of treatment.



Event Review Pro reports (created from data captured by the MRx) enable you to review the sequence of events and care of your patients.

savings for patients experiencing STEMI. In many hospitals, the data can also be sent to their existing Philips IntelliVue system for later viewing in the intensive care unit.

“The whole idea is to improve on the transmission of information,” says James Dunford, MD, medical director for San Diego Fire & Rescue, “and to assure the receiving hospitals that the patient being brought to them with the suspected STEMI is really having it so that they can turn on the cath lab and activate those kind of parallel systems that need to be

happening even prior to the arrival of the patient.”

## After the call

EMS agencies are looking for monitoring devices that allow patient data to be used not just at the time of patient contact and care but also afterward to capitalize on so-called *teachable moments* with EMS providers during call reviews and quality assurance/improvement sessions. That’s one reason Tualatin Valley (Ore.) Fire and Rescue is using Philips’ data management solutions.

The culture at Tualatin Valley Fire and Rescue is research-based, according to EMS Chief Mark Stevens. Data from every cardiac call is downloaded into a central database, where it is reviewed by the EMS officer or physician. “My goal is to have every call reviewed by the crew,” says Stevens. As of 2007, Tualatin Valley has 10 years of data in its internal cardiac registry.

Stevens says data derived from the MRx with Q-CPR, which monitors compression and ventilation rates and quality during CPR, has resulted in a paradigm shift for Tualatin Valley paramedics. Q-CPR “has really [shined] the light on the percentage of hands-on time,” he says. “We think we are doing more compressions than we are.” As a result, the agency’s paramedics no longer stop compressions even to intubate. They are expected to intubate between compressions.

By Keri Losavio & Teresa McCallion, EMT-B

# Data Management Solutions

The **Philips HeartStart MRx ALS Monitor** is an advanced multi-parameter monitor, with 12-lead ECG acquisition and transmission capability, a manual defibrillator and an AED. Monitoring parameters include SpO<sub>2</sub>, NBP, EtCO<sub>2</sub>, two lines of invasive pressure (IBP) and temperature.

What separates the MRx from other monitors is its ability to detect 10 rhythm disturbances and irregularities, including asystole, v-fib, v-tach, extreme bradycardia and extreme tachycardia. Visual and audio alarms alert providers to rhythm changes. The 12-lead ECG algorithm developed by Philips removes noise and artifact prior to generating interpretations. The monitor detects and stratifies early acute coronary syndromes for patients with symptoms of STEMI.

“The MRx’s multi-color screen allows you to easily identify the critical value you are interested in,” says Jim Miller, RN, CFRN, NREMT-P, the Charlottesville-Albemarle (Va.) Rescue Squad’s ALS equipment manager.

The monitor’s color screen—at 8.4 inches, the largest available—displays four configurable waveforms, basic patient information, date and time, and battery status. And when the MRx is in 12-lead mode, a paramedic can view all 12 waveforms on the screen at the same

time. The display can be easily customized so providers can view other data as well.

“The MRx menus are simple to set up and reconfigure on the screen based on your particular needs,” says Mike D’Haene, EMT-P, Granville County EMS, Oxford, N.C.

*‘The MRx’s multi-color screen allows you to easily identify the critical value you are interested in.’ —Jim Miller, Charlottesville-Albemarle (Va.) Rescue Squad*

Captain Zane Gibson, medical services officer for East Pierce (Wash.) Fire and Rescue, says his department especially likes the MRx’s removable memory card that allows data to be downloaded directly to a computer. “Our paramedics are instructed to save the data following a cardiac call or incident requiring airway management,” says Gibson. “That way, there’s no danger of having the data [on the monitor] overwritten by data from subsequent calls. It’s a great feature that no other monitor offers.”

Philips has embraced industry standards for data collection and transmission. “We are utilizing existing standards

“[Q-CPR] has been a good QI feedback tool,” he says.

A valuable tool that can be used to illuminate key clinical information for training and quality assurance and improvement is Philips’ HeartStart Event Review Pro. The program’s multi-waveform view tells the story of a code in a single display. The macro view allows training officers to get right to the teachable moment by automatically highlighting key clinical events, right down to the depth of a compression or the time of the initial shock. The reporting window lets you decide what to include before you print. And case- and system-level reports can easily be e-mailed as text or PDF documents. Included in Event Review Pro are:

- Case reports;
- ECG reports, including ECG full disclosure, ECG pre- and post-shock, ECG selections and 12-lead reports;
- Q-CPR report card;
- Trending reports;
- Response time reports, including total system average response times, total system percentile response times, average response times and percentile response times; and
- Utstein reports.

The Charlottesville-Albemarle Rescue Squad is using Philips’ technology to enhance its quality assurance pro-

gram and ensure it meets response time goals. “The data we are able to pull from the Philips [HeartStart] MRx has allowed us to monitor how efficient we are in attaining our door-to-cath-lab goals,” says Miller.

*‘We can see what’s going on so clearly with the MRx’s capabilities & trending that it’s easy to justify our transportation of the patient to the cath lab.’ —Mike D’Haene, EMT-P, Granville County (N.C.) EMS*

## Summary

EMS personnel are in a unique position to capture important patient information early in a cardiac event. With the right tools, that data can be sent to the hospital ahead of the patient and used to expedite the next level of care. Later, that data can be used for crew education, quality assurance and improvement, and to support changes in protocols and procedures. [JEMS](#)

*Keri Losavio is an editor with Elsevier Public Safety. A.J. Heightman, EMT-P, is the editorial director for Elsevier Public Safety and the editor-in-chief of JEMS. The authors thank Teresa McCallion, EMT-B, and Patricia Krpesh for their assistance in preparing this article.*

whenever possible,” says Brendan Shea, Philips’ product manager for ALS data management solutions. Thus, data from the MRx are XML-formatted, enable NEMSIS-compliance and can be wirelessly transmitted via a Bluetooth-enabled cell phone or even a two-way radio using the General Devices Rosetta-Lt.

## 12-Lead Transfer Station

The 12-Lead Transfer Station is a software-only solution that doesn’t require expensive, dedicated hardware or ongoing monthly contracts not budgeted by an EMS agency. It can run on existing PCs and allows an ED to receive 12-lead information once and then automatically, simultaneously broadcast it to many locations. This saves time and allows the EMS provider to focus on the patient. The software features a wide variety of delivery options: It can be displayed on a monitor, printed, faxed, e-mailed and forwarded to other servers or to an ECG database. It can send 12-leads to the Philips TraceMasterVue or the GE Muse cardiology database via Datamed format translator software from Engineering Solutions Inc. The best part is that it allows for complete integration of the pre-hospital data into the hospital’s existing systems.

## Data Software Developer Kit

The Philips Data Software Developer Kit (SDK) delivers on the company’s philosophy of open systems and interoperability, allowing for third-party access to data from the MRx. The SDK is built with the latest MS Windows development tools (C#, .NET Framework) to shorten data

*‘The MRx menus are simple to set up & reconfigure on the screen based on your particular needs.’ —Mike D’Haene, EMT-P, Granville County EMS, Oxford, N.C.*

integration development time. “Philips reporting tools are built on the same data pipe that we give our partners,” says Shea. The SDK includes viewer/printer utilities. Data appear inside ePCR applications, so there’s no need to run a second proprietary application. The data schema makes it easier for ePCR vendors to comply with NEMSIS.

## Philips solutions don’t stop at the ED

Data captured by the Philips HeartStart MRx can be fully utilized by a hospital’s existing data network. The MRx can be programmed to send data directly to multiple locations. Once received at the 12-Lead Transfer Station in the hospital, it can be forwarded into the hospital’s ECG database and accompany the patient throughout their care. Philips offers a continuous chain of data:

- Philips TraceMasterVue receives and archives 12-lead ECGs so they become part of the patient chart;
- Philips Allura Xper FD systems provide the fluoroscopy that cath labs use to insert the balloon in door-to-balloon measurements; and
- Philips IntelliVue patient monitors enable clinicians to see the presenting 12-lead at bedside and provide ST monitoring/mapping. [JEMS](#)

# Quality Counts

## Q-CPR: A tool for improving CPR performance

If all of your information about cardiopulmonary resuscitation (CPR) came from movies and television, you'd think that survival rates must certainly approach 100%. Unfortunately, the reality is much more discouraging. Less than 5% of cardiac arrest patients are discharged from the hospital nationally, and those numbers have not changed significantly in the past 30–40 years. In addition, several recent studies have found CPR quality during actual cardiac arrest deficient.

The consensus of the American Heart Association (AHA) and other experts is that better quality CPR leads to improved survival rates. The AHA 2005 Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Guidelines summarized multiple studies, recommending “rescuers should push hard, push fast (rate of 100 compressions per minute), allow complete chest recoil between compressions, and minimize interruptions in compressions for all victims.”<sup>1</sup>

The problem is that even emergency responders with a high level of training and experience find it difficult to assess the quality of their CPR during a cardiac arrest call, even during the same call. So how do responders know that their CPR is remaining consistently up to standard? A study by Abella et al hypothesized that real-time feedback during CPR would improve the performance of chest compressions and ventilations.<sup>2</sup> Using an investigational monitor/defibrillator with CPR-sensing and feedback capabilities provided by Philips and Laerdal, the researchers recorded and quantified chest compression and ventilation characteristics in the first five minutes of resuscitation during in-hospital cardiac arrests from December 2004 to December 2005.

These data were compared with a baseline cohort of arrest episodes without feedback, from December 2002 to April 2004. The study concluded that “real-time CPR-sensing and feedback technology modestly improved the quality of CPR during in-hospital cardiac arrest, and may serve as a useful adjunct for rescuers during resuscitation efforts.”

Another study by Edelson et al determined, “The quality of CPR prior to defibrillation directly affects clinical outcomes. Specifically, longer pre-shock pauses and shallow chest compressions are associated with defibrillation failure.”<sup>3</sup>

With room for improvement in CPR delivery apparent, the medical community has been making a concerted effort to improve CPR delivery. In 2005, Philips and Laerdal introduced to the U.S. market the Philips HeartStart MRx with



Q-CPR assists providers in delivering AHA guideline-compliant CPR and serves as an exceptional tool for training and recertifying personnel.

Q-CPR to monitor compressions and ventilations and provide real-time feedback.

### How Q-CPR works

The Q-CPR compression sensor is connected to the MRx via a cable and secured to the patient's sternum using an adhesive pad. The rescuer begins CPR by placing his or her hands on the Q-CPR sensor. When attached to the Philips HeartStart MRx monitor/defibrillator, it provides real-time visual and/or verbal feedback for key elements of quality CPR, encouraging the rescuer to “compress deeper” or “release completely.” If compressions are not detected, it will indicate the number of seconds since the last compression. Q-CPR also monitors ventilations, indicating rate and duration using an illustration of a set of lungs on the MRx display. Visual and verbal feedback for ventilation rate is provided to help prevent hyperventilation.<sup>4</sup>

### Implementing Q-CPR

The Aurora Fire Department, serving the second largest city in Illinois, was one of the first departments in the U.S. to begin using Q-CPR. EMS Coordinator Russ Glass says there was some initial resistance to using the equipment.

Some responders were concerned that the Q-CPR sensor comes between them and the patient. They were also put off that bystanders and family members can hear the audio feedback regarding performance—including instructions to correct technique—during CPR. Some paramedics feared this would cause onlookers to question their ability.

Glass understood how his crews felt and allowed them to use the optional mute capability. “The field is not a surgical room. We have family members, not nurses all around us as

we work,” he says. With or without the audio, Glass believes Q-CPR and the monitor provide important feedback. “I am seeing better resuscitation, more effective use of shock. I’m seeing teams working better together,” he says. “These types of devices help us do a better job.”

He is confident EMS agencies can overcome such objections with training. “Besides, it doesn’t talk to you at all if you’re doing good CPR,” he points out.

### Using Q-CPR in CQI

The Philips HeartStart MRx offers the ability to capture Q-CPR data during resuscitation for later review. Tualatin Valley Fire and Rescue, a combination career and volunteer agency in western Oregon, has been collecting data as part of the Resuscitation Outcomes Consortium (ROC) study, a federally funded program implemented to improve survival rates for cardiac arrest victims. “EMS’s priority this year is resuscitation, and Q-CPR is a big piece of that,” EMS Chief Mark Stevens says. Data from cardiac arrests is downloaded into a central database where it’s reviewed by an EMS officer or physician. It is then used for case reviews, training purposes and overall quality improvement.

“It’s been a good QI [quality improvement] tool,” Stevens says. In particular, it has demonstrated to crews the actual percentage of hands-on time during resuscitation. As a result, Stevens says, paramedics at Tualatin are continuing to administer compressions during endotracheal intubation.

*I am seeing better resuscitation  
[with Q-CPR], more effective use of shock.  
I’m seeing teams working better together. These  
types of devices help us do a better job.’  
—Russ Glass, Aurora Fire Dept.*

Stevens points out that Tualatin is now seeing an average of 12–14% of CPR patients survive to discharge, and most are neurologically intact. “We just didn’t see that before,” he says.

### Improved training

In addition to its use on calls, Q-CPR is being used by departments to train members of the public in CPR. “Q-CPR provides instant feedback that greatly improves the quality of training,” says Zane Gibson, medical services officer for East Pierce Fire and Rescue in Bonney Lake, Wash. He says, “Students love to compete against each other to see how long they can go without triggering the voice prompts,” which provide corrective feedback. When CPR is done correctly (within AHA guidelines), the device is silent.

### Improving survival rates

According to the American Heart Association, sudden cardiac arrest is a leading cause of death in the U.S., claiming an estimated 325,000 lives each year.<sup>5</sup> Although it’s nearly impossible to determine exactly how many cardiac patients would be saved by improving the quality of CPR, experts agree that the

key to survival appears to be early—and effective—CPR combined with defibrillation. With a determined effort from the medical community to find and implement new ways of improving CPR, surviving a cardiac arrest won’t just be a movie-land fantasy. **JEMS**

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# Think Current

## The true measure of defibrillation therapy

Defibrillators have been characterized by *delivered energy*, but it has long been known that *current* is a more physiologically relevant measure of defibrillation therapy.<sup>1,2</sup> Tang et al confirmed that shocks at 150 J are as effective as shocks at 200 and 360 J and minimize post-resuscitation myocardial dysfunction.<sup>3</sup> The Tang study also suggests that peak current is a more appropriate measure of defibrillation dose than energy and average current. Further, it found survival was maximized, and myocardial dysfunction was minimized, by using a biphasic waveform that simultaneously delivered higher peak current while minimizing energy and average peak current—like the Philips waveform.

In a randomized trial, the Philips waveform supported 96% first-shock efficacy and 98% three-shock efficacy.<sup>4</sup> In an observational study of AEDs in clinical use that has run continuously for over a decade, the Philips waveform has demonstrated 90% first-shock efficacy and 99% three-shock efficacy.<sup>5</sup>

Gliner et al clearly demonstrated the importance of waveform tilt for defibrillation performance in an extensive study that was the foundation for the development of the Philips waveform.<sup>6</sup> Higher tilt waveforms, associated with relatively small capacitances, were more effective at lower energies than similar waveforms with lower tilts (and larger capacitors). As with any medical therapy, a more efficient dose is generally preferable for safety reasons. Therefore, Philips implemented a highly efficient low-energy, low-capacitance waveform in recognition of this fact.

The performance of individual shocks was clarified in a study by Niemann et al, sponsored by Medtronic, which instrumented swine hearts with sensors to register voltage gradients local to the myocardium while measuring delivered energies and peak currents associated with transthoracic shocks from four commercially available defibrillators: a monophasic damped sine Medtronic defibrillator and biphasic defibrillators from Medtronic, Zoll and Philips.<sup>7</sup> Voltage gradients local to the myocardium are directly responsible for defibrillation, and the investigators sought to determine which externally measurable parameter, energy or current, was most predictive of voltage gradients.<sup>8</sup> They documented a close association between peak current and myocardial voltage gradients. The relation between delivered energy and myocardial voltage gradients was not statistically significant. As shown in human simulations, the Philips device delivers a substantially higher peak current (21 A average) at 150 J and a higher myocardial voltage gradient (10 V/cm average) than the Medtronic biphasic device (16 A, 7 V/cm) at 150 J. The

Zoll device's performance was intermediate.

This helps explain why another out-of-hospital trial indicated a benefit of energy escalation. The devices in that trial were the relatively low-current Medtronic design.<sup>9</sup> The high-current Philips design has been shown to perform as well in subsequent as in initial shocks, requiring no escalation.<sup>10</sup>

In light of the prevailing guidelines for resuscitation that recommend substantial periods of CPR between successive shocks, it is more important than ever to deliver a highly effective shock dose on the first and every defibrillation attempt, as the Philips defibrillators do.<sup>11</sup> **JEMS**

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# Cool Temps

## Continuous temperature monitoring during cardiac arrest care

The use of post-resuscitation hypothermia for victims of out-of-hospital cardiac arrest is becoming more pervasive and has gained widespread, if not national, acceptance.<sup>1-4</sup> Few will disagree that non-neurologically intact survivors of ventricular fibrillation/pulseless ventricular tachycardia arrests should receive this treatment, and many agree it should be utilized for arrests that result from other cardiac dysrhythmias, such as pulseless electrical activity (PEA) or asystole. Many questions about the optimal utilization of this therapy, however, remain unanswered.<sup>5,6</sup>

One of the most important questions relates to the optimal time to treatment for this therapy. Two prominent trials used a six-hour time window to achieve target temperature; it appears this window was more a matter of the practical time required to achieve the temperature than a scientifically derived optimal time to treatment.<sup>2,3</sup> In other words, there is insufficient evidence to conclude that the six-hour window should be a standard. Indeed, results from animal trials and expert opinion suggest that the earlier the temperature is achieved, the better the outcome.<sup>7,8</sup> Preliminary evidence suggests it's safe to begin infusion of cold saline during resuscitation rather than waiting until return of spontaneous circulation (ROSC).<sup>9</sup> Therefore, an argument could be made that not only is six hours too long to wait for cooling, but waiting on ROSC to begin the therapy may diminish its impact.

*Animal trials suggest that the earlier the temperature is achieved, the better the outcome.*

As we begin to consider this therapy during CPR for cardiac arrest victims and perhaps during EMS transport for other conditions, such as spinal cord injury or near-drowning victims, it is imperative that accurate temperature measurements be obtained and recorded. Ideally, these temperature measurements will be incorporated in the same data stream as SaO<sub>2</sub>, EtCO<sub>2</sub>, ECG rhythm and vital signs. Preliminary animal data suggest that mild hypothermia improves efficacy of defibrillation, slows deterioration of fibrillation waveforms, and does not adversely affect ACLS drugs.<sup>10-12</sup> Reviewing the correlation between temperature and other physiologic parameters during human treatment, however, is an evolving area of research. In the mean time, accurate and continuous data regarding patient temperature is essential to ensure patient safety and to determine the potential benefits of early induction of hypothermia. [JEMS](#)

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During a cadaver lab, an instructor demonstrates the use of an esophageal temperature probe for continuous temperature monitoring—an option available with the Philips HeartStart MRx—to measure core temperature.

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