Leading-edge technologies can help improve patient care

DRIVING THE COURSE OF CARE
The Challenges of Clinical Leadership

This supplement is both a tribute and challenge to prehospital EMS systems. It’s a tribute because it recognizes multiple areas where EMS agencies have been leading the way in clinical innovation, technology, educational and operational planning, and resuscitation advances.

It’s a challenge because, in illustrating pre-planning and operational changes that EMS agencies have effectively used to improve their delivery of patient care and resuscitation results, it challenges your agency to do the same.

You’ll read some common themes throughout this supplement, starting with the need for a team approach to deliver high-quality chest compressions through the consistent application of currently accepted standards, and the use of feedback devices as a key to ensuring that consistency.

“Links in the Chain” points out what we often forget: Despite our best efforts, we often can’t arrive in the critical first 3–5 minutes after a cardiac arrest. Bystander CPR continues to be a necessary, but often neglected, area in every EMS system’s response plan. Systems must focus more on this area.

With some EMS agencies still trying to get their local hospitals to accept therapeutic hypothermia (TH) patients from the field, “Driving Toward ‘Cool’ Resuscitation Care” arms you with important facts about the use of cold normal saline in the post-arrest setting and updates you on some dramatic discharge results in New York City.

Dovetailing off the critical aspects of optimal response times, early patient access/care and consistency in the delivery of compressions, this supplement also focuses on two other important EMS challenges: providing care at mass-gathering events and large participatory events such as marathons.

Although most agencies currently cover special events, progressive agencies pre-plan strategic deployment of AEDs and ALS teams, and use Bluetooth transmission devices to send patient data and progress reports to field treatment centers in advance of a patient’s arrival.

It is our hope that these articles will prompt you to think about, and improve, your daily EMS response plans, procedures and equipment and enhance your mass-gathering EMS approach, pre-planning well in advance of your next event.
The treatment of out-of-hospital cardiac arrest (OOHCA) has long been one of the driving factors in determining what EMS care looks like in the U.S. From system design to equipment carried and techniques taught, much of what we do in EMS has been geared toward improving the survival rates for patients who suffer from this occurrence.

In the early years of ALS development and delivery, the focus was on the timely delivery of defibrillation. Although this treatment is still very important, the focus at the start of this century has been on the delivery of “high-quality” chest compressions.

**Focus on Chest Compressions**

In 2005, the AHA’s Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care summarized multiple studies and came to the succinct conclusion that “high-quality CPR” is that in which the “rescuers should push hard, push fast, allow for complete chest recoil between compressions, and minimize interruptions in compressions for all victims.”1 In addition, it recommended that the “rate and tidal volume of ventilations should be decreased” to reduce inadvertent hyperventilation and reduce intrathoracic pressures, two things shown to worsen chances of survival for patients suffering from sudden cardiac arrest (SCA).1 The studies that these guidelines were derived from all indicated that the application of high-quality CPR was a major variable in influencing the likelihood of survival from OOHCA.

The same year these guidelines were being distributed, two papers published in the Jan. 19 issue of JAMA reported poor performance of the application of CPR by prehospital and in-hospital providers when treating patients in cardiac arrest. Specifically, a high percentage of the time, chest compressions rates were too slow, chest compression depth too shallow and breath rates too high.2,3

These studies made it clear to me, as an EMS officer, that the challenge wasn’t going to be teaching these new techniques, but rather ensuring that the techniques were being applied in a consistent fashion that met the goals of high-quality CPR as outlined by the AHA.

**Implementing the Standards**

The Henderson (Nev.) Fire Department (HFD) is a CAAS- and CFAI-accredited department that provides an all-ALS, fire-based system that covers 276,000 people in 104 square miles of area south of Las Vegas.

Coverage for the city of Henderson is provided from nine fire stations that each have ALS engine companies. Seven of the nine stations also have an ALS rescue unit staffed with two firefighter/paramedics. Calls for cardiac arrest account for approximately 3% of our total EMS call volume, which was 15,555 in 2009. (For more information, visit www.cityofhenderson.com/fire.)

In October 2005, the HFD began the process of implementing the new guidelines. One of our first established goals was to create a team-based approach to handling cardiac arrests. Four critical positions were identified:

1. Compression technician
2. Monitor technician
3. Ventilation technician
4. Medication technician

Each position is responsible for accomplishing an overall goal and following steps to achieve this goal.

All cardiac arrests that occur in Henderson are sent the following resources: the nearest police department unit with an AED, an ALS rescue unit and an ALS engine/truck unit. This response force ensures that all positions for the team-based approach get filled and that a minimum of two paramedics are on every cardiac arrest call.

Based on the AHA guidelines, the most impor-
tant position identified was the compression technician and, therefore, this position is filled first. This position’s goal is to ensure the application of high-quality chest compressions: compressions at a rate of 100 per minute and at least 1½ to 2 inches deep for adults, full chest recoil after each compression and interruption of compressions allowed only for defibrillation and kept to less than 10 seconds.

The monitor technician is the second position filled. Even if the only unit on scene is a rescue, the compression technician and the monitor technician positions are always filled. Because we’re an all-ALS system, a paramedic fills the monitor technician position and also assumes the position of code team leader. This person oversees the entire cardiac arrest, ensuring that high-quality chest compressions are delivered, applying proper electrical therapy to the patient when indicated, determining the correct pharmacological interventions and documenting the code using the event markers in the cardiac monitor.

The ventilation technician position is the third role filled. This team member is in charge of setting up the autoventilator. We chose to use an autoventilator so we could precisely control the tidal volumes delivered and the rates at which the patient is ventilated. This position switches with the compression technician every two minutes during the application of chest compressions to minimize rescuer fatigue.

The medication technician is the last position to be filled. This person establishes IV or IO access, and draws up and delivers medications based on the monitor technician’s orders. To serve as a second set of eyes and to minimize medication errors, this position is also filled by a paramedic.

Ensuring Consistent Application of the Standards
As we established this new process, our department’s implementation of and training for the team-based concept went well, and most of the quality improvement/quality assurance (QI/QA) metrics being evaluated, such as consistent application and knowledge of position responsibilities, were being met. However, one key metric was still not being observed on a consistent basis—the application of chest compressions that met all of the goals outlined by the AHA.

This was occurring only about 15% of the time. Despite our best efforts, our system had no good way to provide feedback to the responders on the quality and consistency of the compressions being provided when they needed it most—during the call.

In 2008, the HFD upgraded its aging fleet of monitors and replaced them with equipment that incorporated real-time monitoring and feedback related to chest compressions and ventilations. The monitoring and feedback capability was immediately incorporated into our team-based approach to
cardiac arrest treatment, and the initial training on its use was rolled out during CPR refresher training.

Initial use of the devices presented us with some surprising results. Unlike the studies from 2005 that showed that many prehospital personnel did not push fast enough or deep enough, we observed through the use of real-time chest compression and ventilation monitoring and feedback that our crews tended to push too fast (at an average of 140 compressions per minute) and that we did not routinely allow for adequate chest recoil.

Because our devices allowed for real-time feedback, human errors could be readily addressed at the time they were occurring either in training or in the field during patient care.

Outcomes
Five years after the AHA’s 2005 guidelines on CPR were published, our department has been able to refine our resuscitation processes and implement a team-based approach. We now have two complete years of experience using a CPR monitoring device on patients in our city.

Although we didn’t perform a controlled study, we believe high-quality chest compressions are having a significant impact on neurologically intact survival rates. In 2007, we began tracking cardiac arrest outcome data according to the Utstein criteria. Survival rates are tracked by those patients who are discharged alive from the hospital with a Cerebral Performance Category Scale (CPC Scale) of 1–4. Since that time, we’ve seen our cardiac arrest survival rate increase from 13.5% in 2007 to 20.1% in 2009 for all patients treated for cardiac arrest. In addition, 7.3% of these patients are being sent home with a CPC score of 1 or 2. Review of CPR data post event has also helped us meet our QI/QA metric of ensuring that chest compressions are consistent with the 2005 AHA guidelines.

Conclusion
As we look to the future of the treatment of OOHCA, it’s clear that the application of high-quality chest compressions will continue to be important in the resuscitation of our cardiac arrest patients. Our experience and studies have shown that it can be difficult to meet AHA’s guidelines for chest compressions. However, by using unique approaches and tools, such as a CPR feedback device, we’ve been able to objectively evaluate the quality of our CPR, address issues through training and continue to monitor CPR quality. As a result, we feel we’re on the path to increasing the number of neurologically intact survivors from OOHCA.

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Disclosure: The author has no conflicts of interest with the sponsors of this supplement.

References
It’s 9 a.m. on a warm March morning. You and your partner just finished breakfast at the beginning of a 24-hour tour of duty. All things considered, you’re expecting a typical shift, and the citizens in the district you protect are expecting a typical day at work. Soon after breakfast, things drastically change for you, your partner and several employees of a local business.

The Call
The tones drop, and you’re dispatched for a patient having seizures in an office building located in the northeast corner of your district. You’re familiar with this building because you’ve been there for a few other calls. At this time of day, you expect a seven- or eight-minute response, depending on traffic.

En route, county dispatch advises you that your patient is a 58-year-old male, now reported to be in cardiac arrest. The patient is located in an elevator, which is currently stopped on the third floor of the office building. An engine is added to the response for assistance.

On your arrival to the third-floor elevator lobby, you find a hectic scene. Approximately 30 employees have congregated around the entrance to the elevator. As you and your partner make your way through the crowd of onlookers, you’re surprised at what you find: a middle-age, unconscious man with an AED applied.

A female employee who’s kneeling at the head of the patient anxiously says, “We shocked him, and we think he has a pulse.” You confirm this with a pulse check. The patient’s situation is still dire, because he’s unresponsive with agonal respirations. You and your partner take over patient care and initiate transport to the closest facility.

En route, your patient’s status slowly improves. His vitals are relatively stable, and, although intubated, his respiratory rate increases and becomes more regular. During transport, a 12-lead ECG is acquired following patient reassessment. The ECG is transmitted to the receiving facility emergency department (ED) via your monitor’s recently installed Bluetooth device.

You arrive at the hospital, transfer the patient to a waiting ED team (who has your prehospital 12-lead in

The AHA recommends that CPR with defibrillation take place within three to five minutes after a patient collapses from sudden V-fib cardiac arrest. Due to the time it takes for the 9-1-1 call to be transmitted and EMS crews to arrive, the patient’s chance of survival is greatly enhanced if bystanders have access to an AED and can perform CPR.
hand) and return to the station. You and the team are pleased that your advanced training, technology and the “chain of survival” changed a patient outcome today. During a follow-up, you discover that the patient received post-resuscitation cooling and was transferred to a hospital that continued the connected care approach. A later follow-up indicates that the patient was discharged neurologically intact—more proof that teamwork and connected care made a difference in this patient’s post-arrest quality of life.

The Chain of Survival
Although we often hear it only once every two years when we take a CPR refresher course, the chain of survival is a critical part of any cardiac arrest response.

It starts with a witnessed event and is followed by bystander CPR and AED use, ALS intervention with a prehospital 12-lead transmitted to the ED while the ambulance is on route, ED review of the 12-lead and patient care report prior to ambulance arrival, and diagnosis and hospital interventions, including therapeutic hypothermia when appropriate. It ends with the hospital discharge of a neurologically intact person.

From the first CPR class we take, the chain of survival is committed to our memories. Unfortunately, it’s not often that we get to see this chain work to its full ability. When EMS arrives on scene at a cardiac arrest, far too often the only care being provided is CPR, despite the fact that the American Hospital Association (AHA) recommends that CPR with defibrillation should take place within three to five minutes after a patient collapses from sudden V-fib cardiac arrest.1

But this isn’t always possible with an EMS-only response. Factor in 9-1-1 dispatch times and response times, and it’s hard to imagine many EMS systems arriving on location within three to five minutes after patient collapse. According to NFPA 1710, fire departments should have, at minimum, a first responder with AED capabilities on location within five minutes of the dispatch (four minutes of response time plus one-minute turnout time) at least 90% of the time.2 Because the call must be processed and dispatched by the 9-1-1 center, adding extra time on the front end of the call’s dispatch, EMS response within the three- to five-minute standard may be unrealistic.

In addition, in many EMS systems, NFPA response times aren’t currently possible due to staffing and funding issues. NFPA 1710 is geared toward response standards in career fire departments. Many systems in the U.S. rely on combination career/volunteer response, and others rely solely on volunteer response for EMS. In volunteer systems that do not have on-duty, at-station crew, response times can be longer.

This is where the public can play the biggest role in the chain of survival for cardiac arrest victims. Although it’s not feasible to put a paramedic or EMS unit on every corner, it is possible to saturate your response district with AEDs located throughout the community and citizens trained in CPR. EMS and fire agencies must give more attention to educating communities and businesses to the importance of Public Access Defibrillation (PAD) programs and AED and CPR training in the community. These two elements can be the key to increasing the number of lives saved in your community.

The Chain in Action
The incident mentioned at the beginning of this article represents an excellent example of how the chain of survival is supposed to work in the workplace. The patient’s co-workers initially called 9-1-1 to report that the patient had collapsed and was seizing. The co-workers had recently completed a CPR/AED class at their workplace and mimicked the video they watched as they split up to complete the tasks they had just learned. As two co-workers started CPR, one went to grab the AED and another called 9-1-1.

Because the patient collapsed in front of co-workers who had just completed workplace CPR/AED training, CPR was initiated almost immediately after patient collapse. Too often, CPR isn’t started until after someone contacts the 9-1-1 center and receives instructions on how to do it. In cases of cardiac arrest, these extra seconds lost can mean the difference between life and death for the patient.

Although initiating CPR quickly is extremely important, CPR alone will most likely not resuscitate a sudden cardiac arrest patient. Once the heart is subjected to a lethal rhythm (V-fib or V-tach), quick defibrillation is paramount. Studies have shown that for every minute that passes between sudden V-fib cardiac arrest and defibrillation, survival rates decrease dramatically.3

A more recent study indicates that survival doesn’t decline at a constant rate. The study found that the change in survival rate over time is almost flat in the first four minutes following collapse, then declines steeply until about 10 minutes after collapse, at which point it becomes fairly flat again, because few patients survive when treated this late. Most notable: When EMS does not arrive between five and 10 minutes of arrest, survival declines by 5.2% per minute.4

In our example, the response time was approximately eight minutes. The time needed to recognize the problem, for co-workers to call 9-1-1 and county to dispatch the call isn’t included in those eight minutes. Once on scene, we also had to climb three flights of stairs to access the patient. If CPR hadn’t been initiated by the patient’s co-workers so quickly, those eight minutes represented a significant potential decrease in the patient’s possible chance of survival. An intact chain of survival can negate all of these delays.

After CPR is initiated, quick defibrillation must occur for the heart to have any chance of returning to a normal rhythm. If an AED isn’t readily available, the chain of survival can easily be broken. The Department of Health and Human Services (HHS) and the General Services Administration (GSA) recently collaborated to define guidelines for public access defibrillators in
Some monitors now feature Bluetooth devices that can wirelessly transmit ECGs to the receiving facility ED, connecting care between the street and hospital. The result: When EMS crews arrive, the ED team has their patient’s prehospital 12-lead in hand.

A Final Word
The above case is an excellent example of a successful chain of survival. Although incidents such as this happen every day, countless other victims could be successfully resuscitated with stronger community involvement in the chain of survival. The most critical minutes for a victim of sudden cardiac arrest occur before EMS arrives. It’s impossible to station an EMT or paramedic with an AED at every corner, but it is possible to educate the community and strategically place AEDs through community PAD programs.

The bottom line: A little community effort today could save a significant number of lives tomorrow.

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Disclosure: The authors have received no monetary support from Philips. Berwyn Fire Company utilizes Philips HeartStart MRx monitor/defibrillators and AEDs.

References
In 2005, the American Heart Association (AHA) recommended therapeutic hypothermia for post-arrest management for patients presenting in ventricular fibrillation (Class IIa) and those presenting with bradyasystolic rhythms (Class IIb). In 2008, this recommendation appeared again in AHA’s consensus statement on “Post-Cardiac Arrest Syndrome.” And earlier this year, the AHA published the policy statement “Regional Systems of Care for Out-of-Hospital Cardiac Arrest,” noting that the “time to implement these systems of care is now.”

**Phase I: Cooler Hospitals**

In January 2009, New York City implemented such a regional system of care. Since that time, adult patients successfully resuscitated from non-traumatic cardiac arrest have been transported only to hospitals that developed and implemented a standardized approach to post-resuscitation management, including therapeutic hypothermia (TH). Since the start of this specialized program, more than 2,600 successfully resuscitated patients have been transported to these cardiac arrest centers.

The preliminary data from this program is encouraging. Despite slightly increased transport times, patients who were transported to these centers were 20% more likely to survive to hospital admission. And among those who were admitted, there was a 30% increase in survival to discharge. Therefore, we believe our success has been a result of a standardized approach to post-resuscitation care, not just the implementation of our hypothermia protocol.

We designed our therapeutic hypothermia program to treat a much wider range of patients than many EMS systems. Our patients range in age from 19–94 and include arrests of all etiologies (e.g., respiratory, cardiac, overdoses, drowning) and all presenting rhythms. This expanded protocol for therapeutic hypothermia has shown us very positive results, with nearly 70% of the patients who survive to discharge leaving the hospital neurologically intact.

One patient who received therapeutic hypothermia and survived to discharge (neurologically intact) illustrates the success of our program. Months after her first TH resuscitation, the patient again suffered cardiac arrest, was transported to the same cardiac arrest center, again received therapeutic hypothermia and was discharged a second time—neurologically intact.

This outcome is what every EMS system strives to accomplish, and it’s what every one of us looks for when we implement resuscitation programs and protocols: providing the best care possible based on the available evidence to optimize the patient’s chances at life.

But we must continue to look for ways to benefit those patients who, today, don’t survive, even to hospital admission. This is where the next phase of our project comes into play.

**Phase II: Cooler Resuscitations**

V-fib patients who don’t respond to initial defibrillation attempts and bradyasystolic arrests for whom...
reversible causes cannot be identified have little chance at survival. Few if any of the drugs that we use in such situations result in increased survival rates. We have had little else to offer these patients—until recently, when we began to consider the intra-arrest induction of hypothermia.

For patients requiring multiple defibrillation attempts, reduction of core body temperature improves the likelihood of successful defibrillation. The induction of hypothermia results in the release of endogenous norepinephrine and causes peripheral vasoconstriction, both of which may reduce the amount of supporting vasopressors that we need to administer during the course of their resuscitation and the deleterious effects that come with them.

The use of ice-cold saline to induce hypothermia has been shown to be effective and safe in the prehospital environment when used in the post-arrest setting. And among the mechanisms through which therapeutic hypothermia appears to improve outcomes, many are time-critical processes that begin within minutes of the arrest. This suggests that the induction of hypothermia during the arrest may attenuate, or even eliminate, these otherwise harmful events.

With those factors in mind, the Fire Department of New York (FDNY) and the New York City 9-1-1 system recently embarked on an expanded cardiac arrest protocol that will induce hypothermia during resuscitation when initial efforts (e.g., airway control, CPR, defibrillation and consideration of reversible causes) fail to resuscitate the patient.

Beginning in August 2010, out-of-hospital cardiac arrest patients who don’t respond to initial resuscitation efforts receive the induction of intra-arrest (i.e., preservative) hypothermia via high-volume, ice-cold saline infusion.

Although such an approach isn’t presently a standard of care, this appears to be a physiologically justified therapy for patients for whom we have no other proven therapies to offer.

**Conclusion**

Each of us has a responsibility to our patients to ensure that they receive the highest quality care. For out-of-hospital cardiac arrest, this means developing the mechanisms necessary to ensure that patients are transported to hospitals where they can receive therapeutic hypothermia as part of standardized, post-resuscitation care. It also means continuing to look for ways to improve the standard of care in our own system to best meet our patients’ needs.

This, like past and future improvements to resuscitation care, will undoubtedly be driven from within the EMS community.

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Disclosure: The author has reported receiving honoraria and/or research support, either directly or indirectly, from the sponsor of this supplement. FDNY receives grant funding from Philips Healthcare for other research for which Dr. Freese is also the principal investigator.

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Hundreds of thousands of spectators gather every Memorial Day weekend to sit or stand in the sun for hours, many of them pressed into the crowded infield of the Indianapolis Motor Speedway. Cars fly by them at speeds in excess of 200 mph, sometimes resulting in ultra-high-speed crashes. The Indianapolis 500, held at the world’s largest stadium, the Indianapolis Motor Speedway (IMS), is the crown jewel of the IZOD IndyCar Series, and is known as “The Greatest Spectacle in Racing,” with the largest single-day attendance of any sporting event in the world. Yankee Stadium, the Rose Bowl, the Roman Colosseum, Vatican City, Wimbledon Campus and the Kentucky Derby can all fit inside the racetrack.¹

EMS in the Fast Lane
Mass-gathering medicine at the Indianapolis Motor Speedway
By Geoffrey L. Billows, MD, FACEP

This obviously presents a unique challenge for those responsible for providing emergency medical treatment to the drivers and spectators under arguably the most demanding conditions. As a result, the medical division of the Indianapolis Motor Speedway has gained considerable experience in managing medical services for hundreds of thousands of people.

Mass-gathering medicine is a complex undertaking. Although much has been written on the subject, there remains no universally accepted definition of a mass-gathering event: Some define it as an event attended by at least 1,000 people, while others say it must be 25,000 or more.

In reality, the number of attendees is only one of the criteria used to define a mass-gathering event. Paul Arbon, in a review published in Prehospital and Disaster Medicine, defines a mass-gathering event

Hundreds of thousands of people attend the Indianapolis 500 each year. The combination of medical conditions among spectators and injuries sustained by drivers creates a challenging situation for EMS. Inset: The safety team helps driver Tony Kanaan out of his car following a high-speed crash.
The exact number of ambulances, carts, ground crews, etc., will depend on the physical layout of the venue & obstacles to patient access.

as “a situation (event) during which crowds gather and where there is the potential for a delayed response to emergencies because of limited access to patients or other features of the environment and location. This potential delay requires planning and preparation to limit (or mitigate) the hazards … and ensure timely access to appropriate health care is available.”

**Preparation**

One standard element of mass-gathering events is that they require a significant amount of preplanning and preparation. Reasonable goals for mass-gathering medical care include:

- The provision of on-site medical care for minor ailments or injuries;
- The ability to alert medical personnel to the need for assistance;
- The ability to rapidly access individuals in need of treatment;
- The provision of appropriate triage in the event of multiple victims;
- The stabilization of patient conditions as necessary;
- The avoidance of needless delay in transport of those requiring more extensive treatment;
- The preservation of the functionality of local EMS systems, to avoid overwhelming the community surrounding the event site; and
- Partnering with competent equipment and supplies manufacturers to provide standard-

**Tips for Special Event EMS Operations**

- Be flexible. Don’t hesitate to reallocate or reassign resources as crowd dynamics change.
- Plan to ameliorate expected environmental conditions with such resources as misting stations, shaded areas, air-conditioned cooling tents, plenty of drinking water, adequate IV fluids and antiemetics, sunscreen and hearing protection.
- Have a mechanism in place for rapid procurement and replenishment of equipment and supplies. Where possible, standardize lifesaving equipment at the event to ensure continuity of patient care without sacrificing efficiency.
- Maintain an emergency route for ambulances.
- Alternate receiving hospitals when transporting patients from the venue if possible.
- Make sure medical personnel have adequate equipment and resources to do their jobs.
- Document all patient encounters, from roving medics and ambulance responses to patients presenting at first-aid stations and care centers.

**LESSONS LEARNED**

The exact number of ambulances, carts, ground crews, etc., will depend on the physical layout of the venue & obstacles to patient access.

Medical staff should prepare a comprehensive medical plan in advance of each major event that addresses medical direction, level of care, medical reconnaissance, transportation resources, communications, security, public health elements, and command and control. Planning must include all agencies involved in providing resources for the event, including law enforcement, public health services, local fire and EMS services, public utilities and other local health care resources.

**Staffing & Resources**

Staffing considerations are complex and may change depending on the site size or location, number of spectators, physical layout of the venue and obstacles to response. Past experiences should be used to estimate the potential number of encounters and the necessary number of staff members.

A reasonable goal for access to care is to duplicate the standards of the surrounding community. The Department of Emergency Medicine at the Mayo Clinic College of Medicine recommends an aid station every one-eighth of a mile or five-minute walking distance, a BLS response time within four minutes, and an ALS response time within eight minutes of an alert.

To adequately provide EMS for the Indianapolis 500—the largest single-day, single-venue sporting event in the world—we’ve developed a multifaceted approach. The most visible component of the medical division is the Clarian Emergency Medical Center, an infield hospital that’s approximately 6,000 square feet and divided into driver care and spectator care areas, with separate entrances to provide drivers with privacy and security from onlookers. Four driver beds are equipped for hemodynamic monitoring in an area
suitable for trauma resuscitation, and 14 additional beds are capable of hemodynamic monitoring of spectators. A broad array of emergency care equipment is available to treat any expected patient condition. Equipment includes general X-ray, ALS monitor/defibrillators, AEDs, cardiographs and vital sign monitors.

The infield hospital is complemented by 14 first aid stations strategically located around the IMS grounds, 19 ALS ambulances for response to spectator locations, six track surface ambulances, seven golf cart ambulances, eight paramedic teams on foot and two pit medic teams. All ambulances and roving medic teams are tracked from the communications room in the infield hospital, which also communicates with a local emergency department and trauma center so that we can send patients direct to the cath lab and alert the trauma center when an injured driver is en route.

The infield hospital is staffed with the medical director, between six and 10 emergency medicine physicians (depending on track activity), up to 15 registered nurses and an optometrist. All first-aid stations are equipped with AEDs and staffed by medics. All patients are brought initially to the infield hospital.

Although there are typically in excess of 1,200 patient encounters during the 12-hour period during which the track is open on race day, the overwhelming majority are for minor conditions that are easily managed on site, including minor abrasions, sprains, sunburns, nausea and dehydration. This past year, only 26 patients were transported off site, thereby limiting the impact on the local hospitals, although we do have mutual aid plans in place to deal with surge capacity.

Conclusion
Although the Indianapolis 500 is unique in the number of spectators and the size of the venue, almost every community faces the challenges of providing EMS during mass-gathering events, including sports events, concerts, political rallies, parades and fairs. Proper planning and preparation for mass-gathering events is critical to ensuring the safety and well-being of attendees and participants while ensuring EMS is prepared for the potential surge in patient care requirements.

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Disclosure: The author has received no monetary support from Philips. The Indianapolis Motor Speedway has received support from Philips in the form of funding for evaluation and research purposes.

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4. IMS Public and Media Relations Department.
"Runner down." These two words bring instant concern to the medical director of a marathon, as well as reflection on the preparation and planning leading up to and during an event. Although the majority of collapsed-athlete calls tend to be for benign conditions related to the normal physiology of the event and prolonged activity—such as dehydration and heat-related injuries, altered mental status and diabetes-related problems—your response system must be prepared for and anticipate the worst.

**Best Practices**

It’s estimated that six to eight marathon runners will die each year while competing in the U.S. due to the combination of occult disease and superimposed physical and/or environmental stresses. In fact, in 2009, six runners died in the U.S. while participating in half-marathons. And marathon running has increased significantly over the past three decades, with more than 470,000 runners in 2008, up from 25,000 in 1976.

Although regular exercise and increased cardiorespiratory fitness are associated with decreased cardiovascular mortality, there’s still concern that prolonged exercise can lead to morbidity, especially in less-than-ideal conditions. EMS and marathon medical teams must be well prepared for these events; one AED and one ECG monitor at the finish line isn’t sufficient.

During the preparations for medical care at the Bank of America Chicago Marathon, the issue of cardiac death is always at the forefront. The event’s more than 45,000 runners and 1.2 million spectators necessitate a unified and coordinated effort among EMS and the medical staff. More than 1,200 medical personnel and EMS responders are in place to respond to these critical events.

Recently, we’ve collaborated with other large marathons, including the Boston Marathon, and their medical teams, to enhance our responses. The result: In addition to substantially increasing the number of AEDs on the marathon route with the medical teams, we also made sure that all teams are able to access and respond in a rapid and optimal manner to each collapsed runner. These marathon route teams include ALS bike teams, ALS golf cart teams and BLS/AED-equipped foot teams. Between these specialized response teams and the ALS ambulances for the event, the number of AEDs present on race day exceeds community standards for a 26.2-mile course.

We have one AED at every aid station (21) in addition to the ALS/AED equipment on the ambulances and with the bike teams.

Finally, our main medical tents are equipped with 12 cardiac monitor/defibrillators that allow our teams to assess cardiac rhythms and core body temperatures, which is critical in providing exceptional care while still having the capability to respond to cardiac failure.

These measures have been adopted as best practices by several marathons around the world. In the U.S., the Houston and Twin Cities marathons follow our AED and cardiac monitor/defibrillator protocols.

In addition, the Medical Summit of the World Marathon Majors (Chicago, Boston, New York, London and Berlin marathons) in January 2010 identified the use and distribution of AEDs as outlined above as best practices for large-scale marathons. And at the 2010 American College of Sports Medicine conference, Bill Roberts, MD, highlighted the use of AEDs in his lecture, “Avoidance of Adverse Outcomes in Marathons.”

The bottom line: Medical directors of mara-
thons realize sudden cardiac arrest can and will occur during competitions, and EMS and marathon medical teams must be prepared to respond as rapidly as possible to give those runners a chance for survival.

Monitor & AED Placement
In the past few years, there have been several instances where AEDs and cardiac monitor/defibrillators have played a key role in saving runners’ lives. During the 2009 Houston Marathon, medical staff using a cardiac monitor/defibrillator determined that a runner was having a heart attack. The runner was transported to the hospital and found to have a blocked artery, which was opened with a stent. And, during this year's Houston Marathon, a bike medic used an AED to deliver a shock on a runner at mile 13. The runner was transported to a nearby hospital and was conscious upon arrival.

At the 2010 Boston Marathon, an AED made the difference in the life of one runner. The 62-year-old runner collapsed approximately two miles from the finish line; although EMS providers responded rapidly, he was lifeless when they reached him. They immediately began chest compressions and applied the AED, which called for a shock. After a focused clinical effort by the medical team and EMS, the runner’s vitals returned.

In Chicago, we’ve used cardiac monitor/defibrillators to assess dysrhythmias in runners who presented with “palpitations or dizziness.” We’ve found that the ability to rapidly assess the cardiac etiology of their condition allows immediate diagnosis and decisive management on the marathon course and at the finish line.

Management of heat illness in marathon medicine is also vital, and the monitor/defibrillators deployed at our event allow for real-time rectal temperature measurement in the most critically ill runners, providing for rapid diagnosis and, thus, on-site treatment to reduce morbidity. During our cooling measures we can continuously monitor the runner’s core body temperature and avoid over-cooling or hypothermic conditions. This additional diagnostic data has enhanced our management of heat illness.

Additional innovative measures continue. Realizing that a rapid response is critical, we plan on providing a chest compression and AED video tutorial to the 12,000 volunteers scheduled to be involved in the next Chicago marathon. This effort should create more bystander emergency response capabilities for race day and provide the greater community with trained personnel long after the event is over.

Conclusion
As marathons increase in appeal, so will the challenge of addressing the variety of runners and their medical conditions. Preventing and treating the incidence of marathon-related cardiac death is a critical part of this challenge. Technology and best practices will continue to evolve, but our role as medical providers and also as community bystanders remains the same: Provide and respond with the best care possible.

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Disclosure: The authors have reported no conflicts of interest with the sponsor of this supplement.

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