Embattled Survivors Give Lifesaving Advice

By JOHN MORRISSEY

It was the fourth major tornado in 14 years to cut a swath through Moore, Okla. — the second to be rated an EF5, the deadliest kind. This time the city's two-story, 45-bed hospital was directly in the path of disaster. One consoling factor: City and hospital leadership had learned lessons from the previous twisters, as well as from the 2011 EF5 that hit St. John's Regional Medical Center in Joplin, Mo.

Nevertheless, Moore was about to learn a lot more.

Catastrophes mercifully don't occur all that often, but when they do, there are specific ways they play out, both predictably and unexpectedly. And like a crime scene, they represent in their rarity a set of forensics to review in order to reassess, rethink and reinvent preparedness — whether for natural disasters, acts of terrorism or a concert grandstand giving way.

Beginning in earnest after the Sept. 11, 2001, terrorist strikes and 2005's Hurricane Katrina, the health care field has been jolted into "recognition that disasters can come in many shapes, many sizes in the community, and the need to be prepared is critical," said Leslie Porth, vice president of health planning for the Missouri Hospital Association. That means heeding what others go through.

"Since Hurricane Katrina, there has been a great evolution in hospital preparedness nationwide, quite frankly based on the lessons learned here," said Karen DeSalvo, MD, New Orleans health commissioner.

Hurricane Katrina taught stark lessons about the need to react regionally during a disaster. In Joplin's case, the tornado was catastrophic, causing more than 150 deaths and more than 1,100 injuries. St. John's, a member of the Mercy health system, took a direct hit, causing the loss of six lives there. Still, intense coordination and a clear mutual-aid agreement among area health care organizations generated speedy response, diverted the injured away from the damaged hospital and helped keep the storm's aftermath from being even worse.

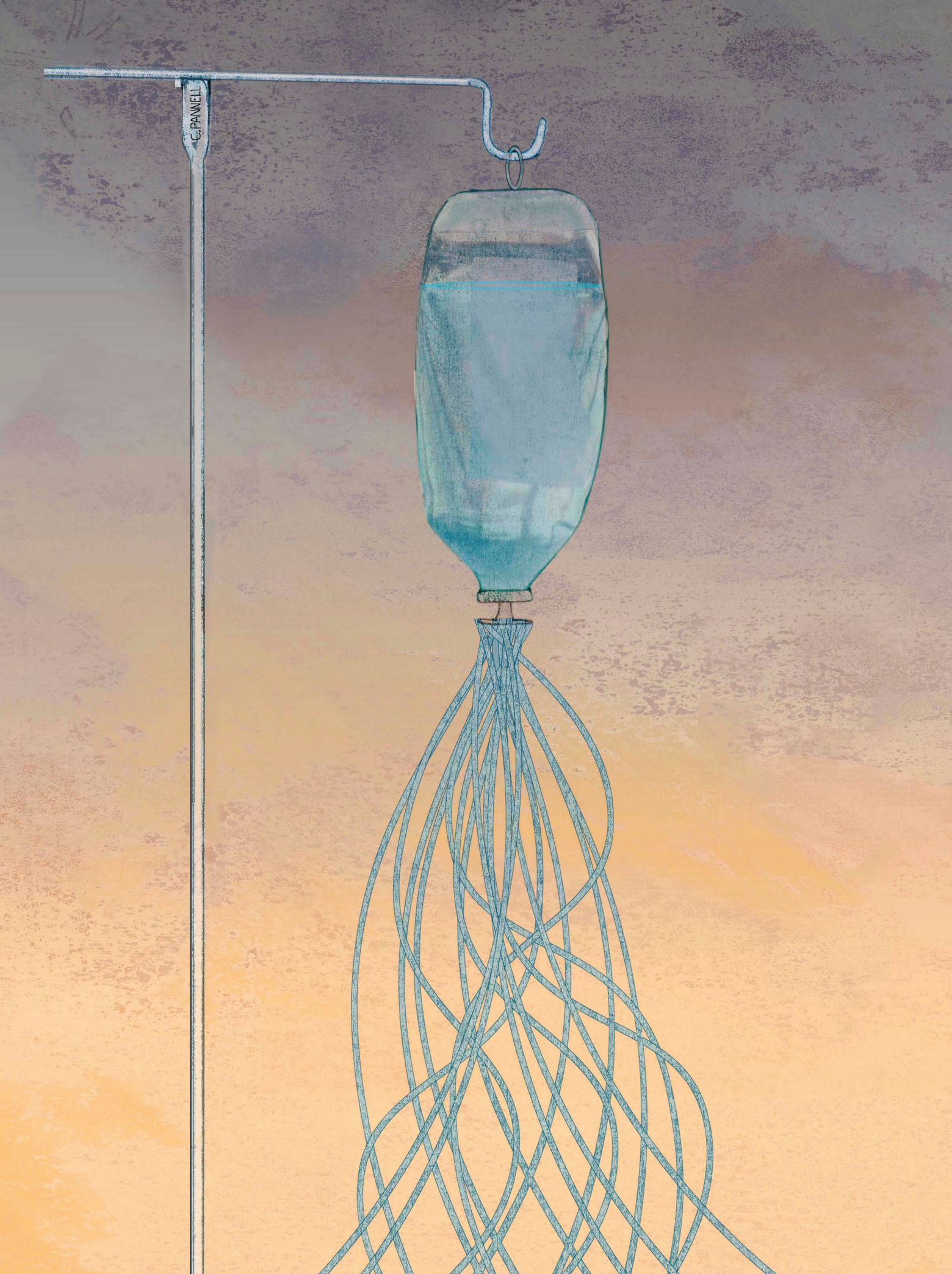
The hospital continued to provide medical services after the tornado, progressing from a treatment area in a local hotel to a M*A*S*H-like outdoor unit in the hospital parking lot to two successive modular constructions. In March 2015, rebuilding will culminate in the opening of Mercy Hospital Joplin, a state-of-the-art facility whose engineering is guiding disaster-proofing across the hospital industry.

At Moore Medical Center in Oklahoma, where half the second floor blew away and what remained was a twisted maze, the scene was a memory to preserve rather than forget, said David Whitaker, president and CEO of Norman (Okla.) Regional Health System, which owns the Moore hospital. "Every one of these structures you see is invaluable — you can't put a price tag on what you learn after an F5 hits. It's tough to put into words all the knowledge that you get."

Most hospitals can learn secondhand. Ascension Health's St. John Medical Center in Tulsa, Okla., is in a direct line between Joplin and Moore — a suburb of Oklahoma City — but to date, no tornado has hit it. Even so, "Every time an event occurs, we up the ante, realize that whatever we called 'prepared' before might not be quite as prepared as we once thought," said Keith Veit, director of emergency and trauma services.

RECOVERY BASICS

More than a mile wide, the tornado that hit Moore on Monday, May 20, 2013, was over by 3:30 p.m., and by 10:30 that night, "we had a relocation plan on paper and started early Tuesday morning to make that a reality," said Whitaker. The health system did not have temporary space specifically identified for use in the event of a disaster, but there was office space in a medical building that Norman Regional previously owned, plus some leased spaces


C. PANNELL

SHELTERING WALLS ATTRACT ONRUSH OF PEOPLE, PETS

When Moore Medical Center took a tornado's direct hit on May 20, 2013, more than 300 people were crowded into the smallish Oklahoma facility, and most of them were neither patients nor staff. More than 200 vehicles were in the parking lot and subject to being thrown against the building. At work was the predictable assumption of hospital as haven — which may not be the case at all, and may, in fact, complicate disaster response.

"The building was truly a nightmare," said David Whitaker, CEO of Moore's parent system, Norman (Okla.) Regional Health System. "And the miraculous thing is there were no deaths; reportable injuries were minor bumps and bruises." Miraculous because amid heroic efforts of staff to protect their ill or injured patients, "you've got 200 people trying to get into the hospital thinking it's safe, it's a public shelter — and it just creates a lot of chaos and it sets up some very, very dangerous situations."

"It's always a community's response to feel they're compelled to go to the hospital or to the emergency department lobby," said Keith Veit, emergency department director at St. John Medical Center, Tulsa, Okla. "They feel some sort of sense of security, that they would be close to the people that could render aid — and in doing so, they do create somewhat of a challenge as we try to manage the crowds."

It's the same with every tornado warning, and families bring all they can with them, Whitaker added. "I've been in Norman 13 years, and I was in Wichita Falls, Texas, for 19 years and went through a huge tornado in '79, and it was the same thing even back then — people seek shelter at hospitals. And not only do they bring their kids with them but they bring their pets: their dogs, their cats, their snakes, their birds."

Whitaker worries that hospitals' luck may run out some day, and a tornado may cause "major, major losses of life" in a facility full of people from the community. "That's a conversation that needs to occur within the hospital industry," he said.

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Hospitals in the Oklahoma towns of El Reno and Yukon, near the path of the Moore tornado, encountered the same onrush of neighbors. At a regional debriefing, said Veit, the consensus was that communities need to be educated that other areas are more appropriate for shelter — but that will take time.

"We're two, three generations into people going to the hospital for shelter, to be close to that safety net," he said. "We need to retrain, just like we need to retrain people that we shouldn't be using the emergency department or trauma centers for primary-care clinics."

In New Orleans during and after Hurricane Katrina, Tulane Medical Center hospital employees were bringing their children and pets to work, and many were then stranded during the storm's catastrophic aftermath, said Karen DeSalvo, MD, New Orleans health commissioner, who was a physician leader at Tulane University School of Medicine back then. Officials had to emphasize that hospital staffers were there to work, not to shelter family. But Tulane and other hospital systems have set up alternative shelters — in summer camps, temporary structures or rented space — where workers and their families can stay until things return to normal, DeSalvo said.

Also during the Katrina disaster, employees at the New Orleans VA Medical Center initially were told they could come in to take shelter and bring family, but that was before the mayor's office made clear that the hospital could not expect any aid in a disaster, said hospital official Liz Failla. So it adjusted the plan to minimize the number of people on campus — a fortunate step, she said, because there would have been many more people there for the historic hurricane's fury.

Human nature being what it is, however, keeping people away from the hospital so it can operate effectively "would certainly be the ideal, but when people are in panic mode and they're concerned for their lives, I think they're going to go to the last light on," said Marti Jourden of St. Anthony Hospital in Oklahoma City.

The 115-year-old hospital has the benefit, though, of an old system of tunnels between campus buildings, and during the 2013 El Reno tornado, thought to be the widest on record, St. Anthony sheltered more than 1,000 people. "The neighbors know that we have those things, and even if they didn't, they would still come to the hospital," Jourden said.

at the far southwest side of Oklahoma City that yielded places for physicians to move their practices. "Seven days after the tornado, they were able to see patients in their relocated office," Whitaker said.

As for the hospital, work began immediately on designing a modular replacement. "We learned from our friends at Joplin," Whitaker said. "Two days after the tornado, we were on the phone to the folks at Mercy," the 32-hospital Catholic system spanning Missouri, Oklahoma, Arkansas and Kansas.

Mercy's St. John facility also had no home in the aftermath of the Joplin tornado, which blew out the hospital's windows and inside walls and destroyed adjacent medical office, rehab and cancer facilities, said John Farnen, Mercy's executive director of planning, design and construction. A command center opened first in Springfield, Mo., and then relocated to the Holiday Inn in Joplin, which also became the site of a medical treatment area with mobile diagnostic equipment. A mobile military hospital used in training at a National Guard unit in Branson, Mo., was taken apart and reassembled in the parking lot of the Joplin site, and "within one week of being hit, we were up and running in the field hospital," Farnen said.

That was good for the time being, but hospital executives had to figure out how to survive the more than three years it would take to design and build their vision: a tornado-safe bunker of a hospital (see sidebar). The first priority was being able to brave the elements — the usual kind. "We wanted something more substantial, especially before winter hit," Farnen said. "We didn't want to ride out the winter in the tent, so we went to more of a modular hospital, which came out in sections and set down on a platform. We just assembled that, and that was up and running in August of 2011."

Next came another modular, but more tornado-resistant, structure, shipped in 224 sections by truck and train. For the 160,000-square-foot, 120-bed facility, which opened in April 2012, designers "hardened" the cafeteria area, building it without windows to make it a sheltering place for patients and others. In patient rooms, windows were designed to withstand 200-mph winds.

UNEXPECTED TWISTS

Moore Medical Center has adopted a similar modular plan as a for-now fix that will buy the two to three years needed to construct a permanent facility, said Whitaker. The new hospital's design will address structural and other tornado-related problems brought to light by the Moore and Joplin disasters. For example, nothing is safe in a tornado unless it can withstand not only 200- to 300-mph winds, but also damage from flying things weighing tons. At the Joplin hospital, which already was weathering a power outage during the storm, an air hammer landed on the backup generator and put it out of commission, costing the lives of five patients on ventilators.

At Moore, a vehicle landed on the hospital roof, and a commercial trash container crashed through it. "Our generator survived, which was a negative," said Shane Cohea, the Moore hospital's safety officer. Frayed or severed electrical lines dangled and sparked dangerously, "and we almost had some people injured that way. So we had to have our engineer run out and turn that off."

The lesson is, the nature of the power problem depends on the situation, said Whitaker. "If it's an ice storm in the winter that brings down a main power feed, and the emergency power generators kick on, that's a good thing," he said. "When half of your building is blown away, and you have all these exposed electrical connections, and the generators are still operational and they kick on, you're just setting up an electrocution site for someone who inadvertently steps on one of those exposed wires."

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— Keith Veit

The tornado's ferocity sent the Moore hospital's color-coded evacuation plan, prioritized by levels of patient condition, right out the window along with everything else. Hospital workers rushed to the neonatal ICU to get the newborns away from a heavy concentration of airborne insulation fibers torn from walls and ceilings. Once a viable exit was located, out went patients, employees and others, in no particular order, to a treatment area set up outside.

Such on-the-spot flexibility was part of the planning, Whitaker emphasized. "You have a base plan that everything's built off of, you drill with

enough scenarios, and it becomes ingrained — you don't get caught off guard," he said. "People don't like being pulled away from their regular duties to go through these exercises, but I can assure you that we train for all types of situations."

Whether the scenario involves a hallway hypothetically caved in, or a car stackup, "rather than freaking out and freezing up," Whitaker said, "[with] the repeated training and the constant throwing of different scenarios their way, it becomes part of the fabric: 'It's a challenge, OK, option 1 is closed, what's our option 2? Let's do it.' And so the preparation part is so important."

As is learning from others. Moore learned from Joplin, for example, that evacuation sleds for moving patients during an emergency are "a really, really nice device, if you can get to them," said Cohea.

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The Joplin hospital's evacuation sleds were kept in a spot that tornado damage left inaccessible. Workers had to improvise by unhinging heavy patient-room doors and dragging them down stairwells with patients on top. As part of its disaster plan, the Moore hospital team made sure to store evacuation sleds throughout the building, mainly on higher floors so the sleds wouldn't have to be carried upstairs.

And speaking of the evacuation sleds, here's a tip the Moore hospital team learned firsthand during the tornado chaos: Put shoes on patients who can walk. To get out of the damaged building, Moore's ambulatory patients had to pile onto the sleds and into wheelchairs to be carried or pushed, because they were barefoot amid the broken glass and debris.

TAKING IT REGIONAL

The everybody-help-everybody spirit in the event of a tornado, hurricane or man-made disaster is admirable, but preparedness experts counsel that only successive levels of coordination, planned well in advance from community to region to state and beyond, will get people moving in the most efficient and lifesaving directions.

In Missouri, a combination of emergency-readiness measures by the government and the state hospital association had taken effect in 2011. The statewide advance planning, elevated to a higher strategic level than was the case after 9/11, was triggered by the cascade of regional complications in Louisiana and beyond after Katrina, said Porth. "In those early years, our focus was on equipment and training and skill-building. But since 2005, the emphasis has been on regional coordination, developing partnerships. It was a significant turning point in the evolution of our preparedness this last decade."

Prominent in that advance planning was getting the state's hospitals to see the need for a mutual-aid agreement — and to sign it. The association-administered agreement sets the financial and legal framework for lending or receiving resources, including personnel, during a disaster. "At the point of a disaster, they don't have to pull their legal counsel in and begin wondering and asking questions about, 'Well, if we give this, are we liable? If we send staff, what are we responsible for?' The details have all been worked out," said Porth.

The association had just launched the agreement, signed by 92 percent of the state's hospitals, when blizzards swept through much of Missouri, including Joplin, in February 2011, enabling the plan to be implemented on a small scale.

"It really was serendipitous," in effect an unplanned pilot test just three months before the tornado hit, said Porth. "So hospitals that were giving communication equipment or sending staff or accepting those resources knew exactly what their responsibilities were, their obligations, how payment would be delivered for those staff, how hospitals would bill for services. All that was outlined. It didn't answer every question, but it certainly answered the majority."

In Oklahoma, mutual-aid agreements are coordinated through the Medical Emergency Response Center (MERC) in each large city, and all health organizations sign a memorandum of understanding outlining in advance their participation, said Marti Jourden, a vice president at St. Anthony Hospital in Oklahoma City. From an underground bunker, that city's MERC coordinates city, county, fire, police and health care entities in the metro area. Whitaker said the MERC

called Moore within 10 minutes of the tornado strike to determine the hospital's status and to start routing injuries to other hospitals outside the twister's path.

Governments and health care associations also work together in Louisiana, said DeSalvo, who during storms can be found in the New Orleans emergency operations center in City Hall, along with a regional coordinator whose responsibility takes in neighboring parishes. They connect when necessary with the state operations center, which has someone embedded from the Louisiana Hospital Association. One task the association takes on is coordinating and managing fuel needs for generators. It also helped evacuate high-risk infants and other vulnerable patients during Katrina.

"The public-private partnership evolution is important for the world to know about — government, hospital and nursing home associations," said DeSalvo. By taking on appropriate roles, the health care field "frees up government to concentrate on power and water restoration."

ANTICIPATING, MINIMIZING

While every event is different, there are some common themes in combating whatever is thrown at health care facilities in the tornado alleys of the American heartland and the hurricane regions along the country's southern and eastern coasts. Problems such as preserving communications, managing staff and surviving a sudden surge — be it casualties or floodwater — can be anticipated and minimized.

"Any time there's a disaster and we go back and do a root-cause analysis or review, or do a debriefing, the opportunities to improve almost always are centered around communication or a lack thereof," said Veit. One general theme for readiness: Have alternatives to cell phones, for wireless networks can quickly overload during an emergency, and a storm can knock out cell towers. But those communication alternatives require careful planning, too.

During the Joplin disaster, Porth said, many hospitals and responders had redundant forms of radio or phone communication, as well as disaster-specific paging or web-based systems. But when cell towers went down, some used amateur radios, others satellite phones, still others short-distance devices such as walkie-talkies. Command centers could not be assured that everyone was receiving essential information. Now under development is a sequential order to follow as communication options fail — first this alternative, then that, and so on.

And to pass along a low-tech tip: "Don't give up land lines," said DeSalvo. Even an "antiquated pay phone" is a last resort, she noted.

During a disaster, the wireless system is not only hit with a crush of private cell phone traffic, emergency responders also may take charge of specific channels. That's what happened to St. Anthony Hospital in Oklahoma City during the Moore tornado. The city took over the cell channel that hospital officials normally used to communicate from the main hospital to other campuses, including emergency departments established in outlying health-plexes, said Jourden. But "the landlines still worked, and we value them."

A pivotal lesson from Joplin was the dual crisis of a destroyed hospital and a nearby hospital not destroyed, but slammed with a surge of casualties. "Both of those issues are equally traumatic and stressful and have their own set of challenges," said Porth. Joplin's Freeman Health System received more than 500 patients in the first few hours, about 1,700 total in the tornado's aftermath.

Two years later, several hospitals closest to Moore had to manage the same sort of post-storm patient surge. Though hospitals prepare for sudden spikes in emergencies, the Moore tornado was an extreme that resulted in drastic changes to Oklahoma planning scenarios, said Veit, who talked to other emergency-department directors about it.

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— Karen DeSalvo, MD

"We've learned our lesson," Veit said. "As I sit here in St. John Medical Center in midtown Tulsa, I don't think about 250 patients anymore, I think in terms of a thousand patients."

In New Orleans, preparedness planning revolves around surges in a different sense. Since Katrina, hurricane preparation has shifted to water over wind.

"Flooding is the most catastrophic event in

a hurricane," said Liz Failla, who oversees the design and construction of a new Veterans Health Administration hospital campus in New Orleans. There, preparing for a storm surge is key to everything from patient and staff management to configuring facilities to keep essential operations above the water line.

HURRICANE PREP

Like most hospitals of its time, the old New Orleans VA Medical Center housed its utilities and other physical plant equipment in the basement. In September 2005, the hospital weathered Katrina's wind, but the ensuing storm surge flooded the city and filled the hospital basement with 8 feet of water.

"Essentially our infrastructure was gone, [it] sat there for a few weeks before it could all be pumped out," said Failla. Subsequently, the U.S. Department of Veterans Affairs declared that the hospital could not be salvaged and the best route was to build a new facility.

During subsequent storms, water has continued to be a major issue, but less so because of hospitals' flood-prevention tactics, said DeSalvo. She added that the design brainstorms coming out of the VA construction project, scheduled for completion in February 2016, are influencing reconfigurations among the region's hospitals, both existing and planned.

A pivotal starting point, Failla said, is that "nothing that we consider mission-critical is at the ground-floor level" of the new hospital. The emergency department is at the 21-foot level on the second floor, accessible by a ramp and outfitted with a boat dock if water rises that high.

Other area hospitals have taken the cue to get their emergency departments off the ground floor. "We have the ability to do it from scratch in a new facility, but many other medical centers in the area have had to shoehorn in a second-story emergency department," said Failla.

The first floor of the planned VA hospital consists of administrative offices and other areas considered "sacrificial space" in rising water, she said. Utilities for the campus will operate from the fourth floor, and a high-and-dry supply warehouse will be combined with a second energy plant, with

A BUNKER OF A HOSPITAL

It won't lose power. Its exterior will stand up to the fiercest tornadic winds imaginable. Roofs throughout the campus will be nearly impenetrable. For good measure, the inner part of the new Mercy hospital in Joplin, Mo., will be hardened as both a shelter area and a shield for the main route of lifesaving electrical and gas mains to floors.

The replacement hospital for the destroyed St. John's Regional Medical Center, to be renamed Mercy Hospital Joplin, buries or greatly reinforces all the critical operations or structures that were breached badly in the 2011 tornado, with its 250-mph winds. The aim is not only to survive a future hit, but to keep power flowing, ventilators going and vulnerable patients safe in place, said John Farnen, Mercy's executive director of planning, design and construction.

The first two of the nine floors are underground, where all mission-critical functions will be housed, including the surgery department. Exterior walls are reinforced concrete that support roofs of poured concrete. Hospitals are required to have windows, which all blew out in 2011. To turn that weakness into strength, designers went with laminated glass for patient rooms to prevent shattering. The windows will be built to withstand winds of 110 mph for regular patient rooms or 140-mph winds where patients are not as mobile. For areas such as the ICU, housing patients who cannot be moved, a kind of glass has been invented that is capable of withstanding 250-mph winds and flying debris hitting it at 100 mph.

The first two floors are the ideal evacuation area, but because tornadoes appear out of nowhere, "it's kind of hard to relocate people even off of the floors, so we created protected areas on every floor of the hospital," said Farnen. Such inner cores with reinforced construction will provide shelter when there's no time to move elsewhere in the building.

Flying debris knocked out the hospital's power plant during the 2011 tornado, so the new building's utility plant is three-fourths underground, surrounded by solid concrete walls and roof. It will contain all generators and chillers, plus medical gas systems and boilers that provide sterilization. A tunnel 20 feet underground from the plant to the hospital's lower level supplies all the connections.

In addition, life-support systems in the ICU and other critical inpatient areas have battery backup for individual pieces of equipment, said Farnen. If the building loses both utility power and generator backup, all the life-support equipment will continue to function.

multiple generators for electricity. Fuel and water tanks have the capacity to run the campus for five days with 1,000 patients, if totally cut off from the outside.

The New Orleans area typically loses power after the winds and rain do their damage, and Louisiana regulations require access to generator power, said DeSalvo. Though very few hospitals have whole-hospital generators, most have enough to support critical areas like intensive care, yet 2012's slow-moving Hurricane Isaac taught that one generator isn't sufficient. Even though the wind speed made Isaac more tropical storm than hurricane, it sat overhead for days, pounding the New Orleans region with rain, and first-line generators failed. Lesson: redundant power sources that kick in, one after the other.

Tornadoes form and descend in minutes, but hurricanes provide up to a week's warning. That gives hospitals in hurricane zones the chance to prepare by stripping down operations to the bare minimum. Elective surgery is canceled. Patients in the hospital are classified by their ability to be moved out if a hit seems certain.

"The hospitals have been really aggressive about their ability to both shelter in place but then more appropriately triage — the need to evacuate some more-high-acuity patients and then figuring out how to staff appropriately, not just for disaster but for recovery," said DeSalvo.

RELIEVING HOSPITAL SURGE

"Most of the patients that remain in a hurricane situation are the most vulnerable — those are the ones that could not be discharged safely," said Failla. "If you move them, there's a high risk of something happening."

"What you don't want is the event happening and you're a full hospital, with patients that didn't need to be there," while sick and injured people pour in, she said.

Hospitals also tend to attract local residents seeking shelter and safety during a hurricane or other disaster, which creates its own management problems as well as policy dilemmas (see sidebar). One way to keep unnecessary surges of people from descending on the hospital is a plan to support outpatient sites, home-based care and community shelters in a disaster, all of which relieves pressure on emergency departments, DeSalvo said.

New Orleans has been working on improving the availability of community shelters to accommodate larger numbers of people. "That's not directly related to hospitals, but if you're on the street and looking for a place to go, and the storm's a-coming, the hospital's a typical place that they end up," DeSalvo said. "I don't want ERs to get clogged with healthy people who just need a place to sleep and something to eat."

For Hurricane Isaac, New Orleans set up its convention center for all medical needs short of hospitalization and emergency care. Area health systems also worked to get outpatient services re-established quickly and made announcements that clinics were the place to go for medical questions or to get medications refilled, DeSalvo noted. "That was extremely helpful for keeping people out of the emergency room."

COGNIZANT AND COURAGEOUS

Emergency preparedness should test the imagination, not just move supplies and personnel, said Porth. All hospitals are required to exercise their disaster plans, but some drills may be limited in scope, short in duration or handle only a few aspects of the plan — testing just enough so the plans seem to work.

"Don't stop there," she said. "Don't stop until you 'break' the plan, until the plan doesn't answer the questions that you have and the issues that arise. And then figure the plan some more, and go back and retest." By constantly testing "to the point that you've failed," the result will be "a broader, deeper, more comprehensive plan that will help you in a catastrophic event."

In the final analysis, however, a hospital's disaster plan is no better than the people putting it into action, said Whitaker, of the Norman, Okla., Regional Health System.

"For such a terrible event, the outcomes based on what we were faced with could not have ended up better, and I attribute it to the staff that was in place," he said. "How difficult would it be, knowing that something in excess of 225 miles an hour was bearing down on you, and you're on the second floor of the hospital, and you've got the courage to stay there and cover your patient with your body and take what comes your way? The heart, the courage and the preparation of our staff, that's what made heroes out of those people that were in that building that day."

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JOURNAL OF THE CATHOLIC HEALTH ASSOCIATION OF THE UNITED STATES www.chausa.org

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Reprinted from *Health Progress*, November - December 2013