

# Breathing for the Masses

Ventilatory Support in Mass Casualty Incidents

By Frank G. Rando, PA, CRT, CVT, EMT-P, CHMS

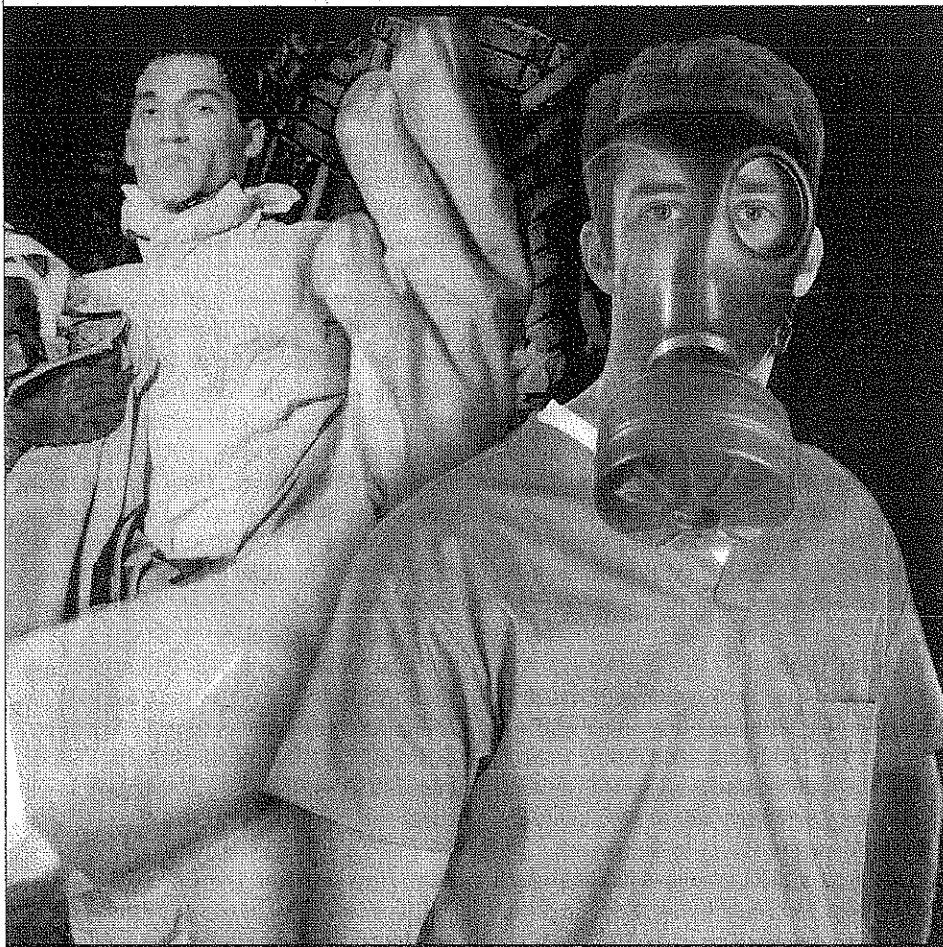


PHOTO ILLUSTRATION: JASON STEIGLEMAN; PHOTOS: JAY WILEY/RYLE KEILINSKI

The U.S. Attorney's Office has called the two-mile industrial section connecting New York City to New Jersey along the Pulaski Skyway "the most dangerous two miles in the U.S." Local and state emergency planners term the area a "disaster waiting to happen."

The region contains highly industrialized centers in Elizabeth and Kearney, N.J., and is considered the most hazardous and vulnerable industrial corridor in the nation. One facility especially worrisome to emergency planners and homeland security professionals pro-

duces chlorine gas, one of the deadliest toxic industrial chemicals. A catastrophic release of chlorine gas from this facility would result in several thousand to 1 million casualties.

Chlorine, a highly irritant water-soluble gas, interacts with the aqueous medium of the upper respiratory tract to form hydrochloric and hypochlorous acids, resulting in irritation and chemical burns in the respiratory tract. Exposure can affect the lower and peripheral airways as well and damage the alveolar-capillary membrane, causing non-cardiogenic pulmonary edema. Acute Respi-

ratory Failure (ARF) and ARDS.

## Case in Point

One clinical case study vividly attests to the toxicity of chlorine. An 18 year-old female presented to an ED with acute onset of dyspnea after swimming. A pool employee had added chlorine to the water while she was swimming laps, and as she turned her face for a breath, she encountered a green cloud hovering over the water. Within minutes, she became dyspneic, weak and presyncopal.

In the ED, she complained of shortness of breath, chest tightness and cough. Her respiratory rate was 28 breaths per minute, and her physical examination was normal. Her arterial blood gases were remarkable for a mild respiratory alkalosis, and she had a PaO<sub>2</sub> of 88 Torr with an FiO<sub>2</sub> of 70 percent. A chest X-ray demonstrated new bilateral infiltrates that primarily affected the lower lobes. These resolved within one month post-exposure.

We must sharpen our assessment and clinical skills pertinent to the care of disaster patients.

She was treated with solumedrol and inhaled beta-2 agonists and progressively improved. Four days after the exposure, she was discharged on steroids and inhaled beta agonists. But the swimmer still complained of dyspnea on exertion and exercise intolerance a year-and-a-half later. And while her clinical outcome was comparatively favorable, she continues to report chronic respiratory effects.

Now, envision a catastrophic industrial accident release of chlorine, ammonia, phosgene, methyl isocyanate or some other pneumotoxicant.

Among the patients arriving in the ED would be some exhibiting respiratory symptoms, some with aphonia/hoarseness with impending airway edema requiring intubation or a surgical airway and others presenting later with impending pulmonary edema.

Caregivers need to ask what they are prepared to do at this point.

## Revisiting Disaster Scene

One of the largest industrial catastrophes occurred in 1984 in Bhopal, India, and involved the release of 25,000 kilograms of

## Look at the Past to Predict the Future

To understand surge capacity and the complexities of disaster management better, clinicians should review the impact of the 1995 sarin nerve agent attack in a Tokyo subway.

During one hour, 500 patients arrived at St. Luke's International Hospital Emergency Department. Many first responders and health care personnel were contaminated by sarin "off-gassing." In all, 640 patients were assessed and treated at St. Luke's.

If even a relatively small fraction of this patient surge, say, 75 patients, presented in acute respiratory distress with impending respiratory failure, their care would require mobilization of Chempack resources (if available) and other in-house antidotes available, airway management equipment and supplies, medical oxygen and benzodiazepines to suppress and to control seizure activity. This is in addition to PPV equipment.

Care would require multiple doses of antidotal therapy like Mark-1 autoinjectors that contain atropine and pralidoxime.

In nerve agent exposures, PPV would be difficult due to the muscarinic effects of acetylcholine accumulation, glandular overstimulation and seizures. These result in excessive airway secretions and bronchospasm, both of which make ventilatory support efforts difficult. Meanwhile, respiratory muscle fatigue, diaphragmatic paralysis and CNS effects may lead to respiratory arrest.

In these patients, antidotal therapy would be critical both to reverse physiological effects of organophosphate toxicity and to facilitate ventilatory support.

But that is only part of the picture. In the first 24 hours, an estimated 5,500 patients were seen at Tokyo area hospitals because of the attack. You must ask whether your facility is prepared for these types of patients.

To get on a solid training ground, facilities should be cross-training respiratory therapists to administer antidotal therapy for organophosphates and some carbamates for toxicological emergencies in addition to other duties they might be expected to perform in a crisis situation.

—Frank Rando

methyl isocyanate, a highly toxic edemogenic gas used in the production of the insecticide carbaryl (Sevin). Over 10,000 people died and thousands were injured. More than 2,500 cases of ARDS and ARF were reported.

This is a mass-casualty event on a giant scale. But other equally broad catastrophes could be fueled by infectious diseases, bioterrorism-related events, explosions or nuclear-radiological accidents. All would require massive respiratory therapeutic and physiological support efforts, including use of positive-pressure ventilation (PPV).

There has been much debate recently concerning availability, deployment and resource allocation of ventilators in mass-casualty incidents. Some efforts are under way to add ventilators to the Strategic National Stockpile (SNS). But in some ways, these types of efforts have led some planners and caregivers into a realm of unrealistic expectations.

While it is essential to prepare for worst-case scenarios, caregivers must still be realistic. We must face the prospect that all who enter our health care system during a mass-casualty event will not be salvageable, despite immediate availability of full-feature mechanical ventilators.

We must try to "do the most good for the most people," a fundamental edict of the tri-

age system. We must apply what we learned from prior disasters to establish, implement and maintain an effective Incident Command System (ICS). We must sharpen our assessment and clinical skills pertinent to the care of disaster patients.

### Rely on Triage

Effective triage and judicious resource allocation will ultimately determine who will be intubated and ventilated during a crisis. Not every patient who presents with an acute respiratory symptom will require intubation and PPV.

We must dispel any notions that all patients who normally would be intubated and ventilated in a pre-disaster setting will be given such support during a disaster. We also need to re-examine closely any notion that full-feature ventilators will be "just around the corner. That is not destined to happen, despite an AARC proposal that 10,000 additional ventilators be added to the nation's stockpile. Full-feature critical care ventilators, albeit optimal, are not cost-effective to be stockpiled. Deployment of them could be unfeasible.

At best, caregivers might expect the release of the Strategic National Stockpile's Eagle Impact and Puritan-Bennett LP-10 transport ventilators following an emergency.

But these would probably not be available for at least 12 hours at the earliest.

Non-invasive ventilation systems and anesthesia-type ventilators, however, might augment a ventilator surge capacity.

**Clinicians need to remember that all disasters are local events and must be managed locally and that all roads lead to the hospital.**

At the same time, automatic resuscitators/ventilators like the disposable VORTAN Automatic Resuscitator/Ventilator can provide relief in emergent and short-term support situation for intra- and inter-facility transports, in treatment areas and triage centers and as back-ups during power failures.

Such devices have been stockpiled at health care facilities and local caches as part of community preparedness efforts. But these are pressure-limited and may not be suitable for patients with a decreased chest wall or ARDS. There is evidence, however, that resuscitators like VORTAN's VAR devices respond to changing compliance at selected pressure settings and are also adaptable to in-line PEEP. They also appear to deliver a stable minute ventilation when compliance decreases from 0.07 to a decreased compliance of 0.02 L/cm H<sub>2</sub>O.

These devices coupled with a multi-patient manifold system using a medical gas source can ventilate seven patients simultaneously. Three multi-patient manifold units, called "E-Vent Cases," can ventilate 21 patients simultaneously.

### Standing on Your Own

Clinicians must always remember they will be on their own for at least the first 12-72 hours. Likewise, they need to remember that all disasters are local events and must be managed locally and that "all roads lead to the hospital." In addition, pre-existing disease exacerbations and the usual weekend night "knife and gun club" casualties are not going to subside simply because there is a flu epidemic or an industrial gas leak.

Some clinicians are currently advocating the use of manual bag-valve mask (BVM) support for mass casualties. But pragmatic clinicians do not see their departments pro-

story continued on page 24



**Mark Junge sports a Statue of Liberty cap as a victory trophy after reaching Times Square in New York City.**

story continued from page 22

cause it allowed him to concentrate on things other than breathing.

On a typical day, Junge covered 40 miles in eight to 10 hours. "I was spreading the gospel of portable oxygen," he said. "The trip, at least the way we traveled, would not have been possible with large, oxygen gas tanks."

Much like Lance Armstrong putting a public face to testicular cancer, or Christopher Reeve doing the same with paralysis, people like Junge are living proof that life can go on for oxygen users.

"It's good that he's out there as a positive image," Chakravorty said. "It draws attention to what people with disabilities can do."

#### **More Trips to Come**

Junge traveled across the country on the historic Lincoln Highway, the nation's first transcontinental auto route. It was a nostalgic and romantic ride. He passed filling stations, cafes, historic markers, main streets, courthouses, little stores and shops. "It was like going back and seeing older America," he said.

Being on a bike gave him the freedom to stop, look around, take in a scene. "You're not separated from the smell of corn or the sagebrush." He met many nice people. He took many pictures.

The long trip did have its share of challenges. While going up some mountains, Junge more than once wondered whether he would make it. On a rainy night in Iowa, with weeks left to travel, he and Ardath were tired and hungry, and Junge lingered over thoughts of quitting. "Did I bite off more than I could chew?" he pondered.

But the pair made it; and now Junge is pondering biking around the world, provided he can line up sponsorship. After the trek to Newfoundland, the next leg would begin in the British Isles. The rest of the world would be tackled after that.

Obviously, biking in foreign countries would be harder than in the U.S. His son warns him, for instance, that Holiday Inns aren't scattered across China.

Junge isn't worried. He'll have Ardath, his one-person pit crew, with him. "I say, 'My wife will figure it out.'" ■

*John Crawford is a freelance writer based in the Boston area.*

story continued from page 10

viding BVM support for a patient surge of 50-100 patients. Such ventilation is impractical and labor intensive and would distract clinicians from performing critical duties like patient assessments and life-saving clinical interventions.

Using non-clinical volunteers to ventilate using BVMs, as suggested by some clinicians, is also not a solution. Even in the hands of a skilled anesthesiologist or respiratory therapist, BVM ventilation is variable at best and quickly produces hand fatigue. Delegation of such responsibilities to others not trained is highly problematic.

BVMs should be available as a back-up but is not feasible for large-scale support.

**In a true disaster, casualties will be given care based on triage decisions.**

In a true disaster, defined as an event that exceeds the capabilities of a response and need exceeds resources, casualties will be given care based on triage decisions dealing with salvageability, viability and resource allocation.

Accurate triage reduces the burden on health care facilities and caregivers. On average, only 10-15 percent of casualties will present in a "serious" enough condition to warrant even overnight hospitalization. This may, however, change significantly based on severity, magnitude and type of disaster.

For example, patients with blast trauma may develop ARDS, air embolism, head trauma and traumatic brain injury, penetrating and blunt chest trauma, incendiary and crush injury and exposure to toxic gases.

Clinicians, in these situations, must be able to perform immediate assessments and diagnosis and implement life-saving procedures such as pleural decompression for tension pneumothorax via needle thoracostomy or chest tube placement; and based on prudent triage decisions, patients suffering from blast-related injuries may require immediate ventilatory support.

Some victims who present with conditions like ARF may be placed in an "expectant" category, which indicates dead or dying. Only if resources become available will the "expectant" category of patients receive medical interventions.

Ultimately, "thinking outside of the box" and implementing an effective tiered clinical decision-making system and judicious use of a "hybrid" system of ventilatory support will reduce morbidity and mortality.

Training respiratory therapists in disaster medicine and incident management is essential. Obviously a new way of thinking is needed to meet any challenges posed by mass casualties. These goals must be realized, so as many people as possible may live. ■

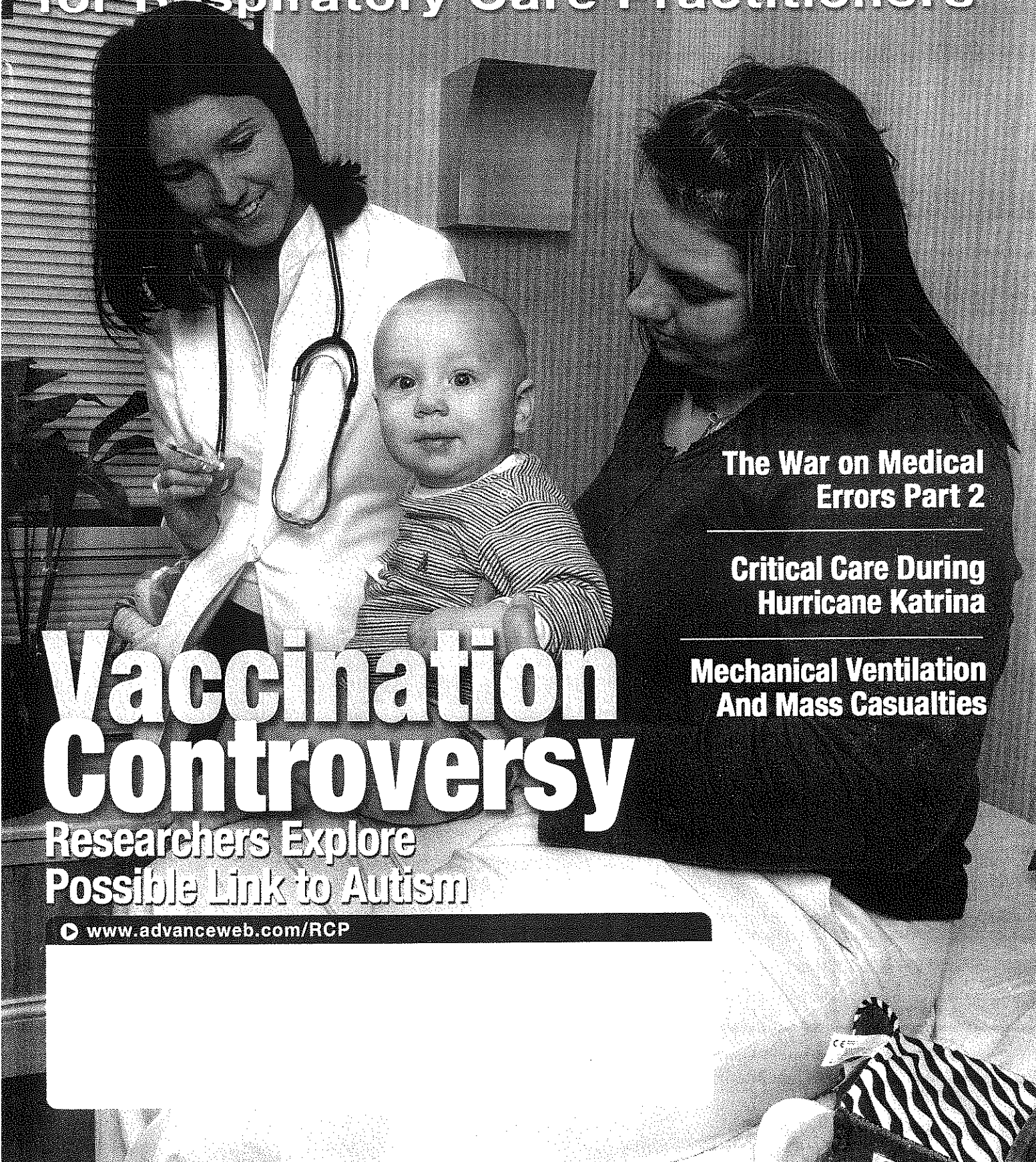
**For a complete list of references and a complete copy of this text, visit our Web site at [www.advanceweb.com/RCP](http://www.advanceweb.com/RCP).**

*Frank G. Rando is a senior faculty/SME for the U.S. Dept. of Homeland Security and as a counterterrorism SME/analyst for the U.S. National Nuclear Security Agency and U.S. Dept. of Energy-Counterterrorism Operations Support. You can reach him at [hazemerg@hotmail.com](mailto:hazemerg@hotmail.com).*

The Nation's Respiratory Care Biweekly

# advance

for Respiratory Care Practitioners®



**The War on Medical Errors Part 2**

**Critical Care During Hurricane Katrina**

**Mechanical Ventilation And Mass Casualties**

# Vaccination Controversy

**Researchers Explore Possible Link to Autism**

► [www.advanceweb.com/RCP](http://www.advanceweb.com/RCP)