

# September 11, 2001, Revisited

## A Review of the Data

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**Hypothesis:** The September 11, 2001, World Trade Center (WTC) attack was a disaster of epic proportion in New York City, NY. It was unprecedented in terms of the number of people who were killed in the bombings, as well as in terms of the volume of patients received at local (New York City) hospitals. The strain on local emergency medical services, hospitals, and the citywide trauma system is still felt today as the hospitals, physicians, and agencies involved struggle to train for similar events that may occur in the future, cope with the psychological and social aftermath, and even pay for the response to the bombing. The objective of this review of the data was to determine the major causes of morbidity (ie, hospital visits) during the hours immediately after the September 11, 2001, WTC attack, as well as to detail the costs involved in the medical response to a disaster of this scale and to identify some lessons learned with respect to the hospital's response to an event of this magnitude.

**Design:** Review of records and cost data submitted by Saint Vincent's Hospital, Manhattan, NY, to the state of New York and federal sources for financial relief from the September 11, 2001, WTC attack.

**Setting:** Saint Vincent's Hospital is an academic medical center of New York Medical College and a New York City–designated level I trauma center.

**Patients:** All medical records for the patients registered at Saint Vincent's Hospital on September 11, 2001, after 8:50 AM were reviewed.

**Results:** The major cause of morbidity for the September 11, 2001, patients was smoke inhalation (30.0%); followed closely by chemical conjunctivitis and corneal abrasions (16%); lacerations, abrasions, and soft-tissue injuries (15.5%); isolated orthopedic complaints (12%); and psychiatric complaints (10%). Multiple-trauma patients were 3% of the patients seen. There were 5 fatalities at Saint Vincent's Hospital.

**Conclusions:** The WTC disaster was a source of major morbidity and mortality to the people of New York City. The possibility that Saint Vincent's will again serve in that role is in the forefront of the minds of everyone involved in updating our contingency plan.

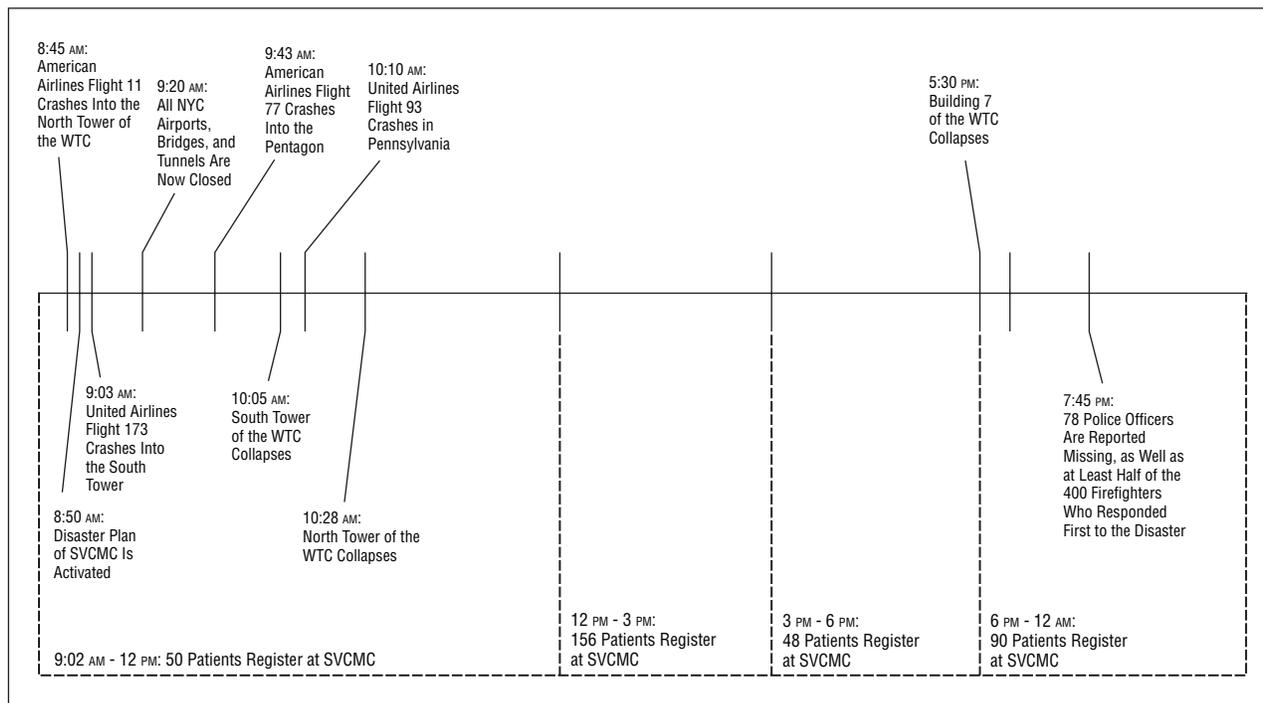
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**S**AINT VINCENT'S HOSPITAL, Manhattan, NY, was founded in 1849 as a charity hospital in the Greenwich Village section of New York City, NY. Now one of the 2 academic medical centers for New York Medical College, Saint Vincent's is at the forefront of the acute care rendered to New Yorkers in time of need. During the 1993 bombing of the World Trade Center (WTC) (February 26, 1993), for example, Saint Vincent's had been the primary receiving hospital for casualties because of its proximity to the WTC. Emergency medical agencies in New York had therefore been trained in this scenario, and contingency plans were in place to deal with the possibility of an attack on the WTC. Saint Vincent's saw 169 patients on February 26, 1993, and admitted 40; the scale of the event on September 11, 2001, was, at the time, anticipated to be orders of magnitude greater.

Saint Vincent's hospital is designated a level I trauma center by the City of New York, and when the city activated its disaster plan on September 11, 2001, at 8:50 AM, Saint Vincent's was once again selected as the main receiving hospital for casualties (**Figure 1**). The hospital accordingly activated its internal disaster plan; a large number of critically injured people from the area of the WTC was anticipated.

Initial reports of events cited a possible private plane crash into one of the WTC towers (the North Tower) at 8:46 AM. The Federal Aviation Administration, by that time, had lost contact with American Airlines flight 11, but its whereabouts were still unknown. Not until 9:03 AM, when United Airlines flight 175 crashed into the South Tower of the WTC, was it released that the initial crash had in fact been that of American Airlines flight 11 and that this was likely a terrorist attack.

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**Figure 1.** Timeline of events affecting response to disaster on September 11, 2001. SVCMC indicates Saint Vincent's Catholic Medical Center; WTC, World Trade Center.

## METHODS

All medical records for the patients registered at Saint Vincent's Hospital on September 11, 2001, were reviewed. Patients registering before 8:50 AM were excluded; patients who were admitted to labor and delivery not as a result of the WTC events were excluded (4 patients). Patients who were admitted to labor and delivery as a direct result of the attack were included. Any patient who was dead on arrival to Saint Vincent's Hospital was included in the review.

Cost data were obtained from the grant proposals filed by Saint Vincent's Catholic Medical Center for relief from federal and New York State sources.

## RESULTS

### TIMELINE OF RESPONSES

Saint Vincent's Hospital was the closest level I trauma center to the WTC attack (**Figure 2**). Within minutes of the attack, visiting hours were cancelled; physician and nurse manpower pools were established by announcing activation of the hospitalwide disaster plan. Clinic physicians and physicians off duty were recalled, and medical supplies, blood, water, and food were brought into the hospital. Monitored beds, including those in the surgical intensive care unit (ICU), trauma ICU, medical ICU, cardiac ICU, cardiac surgery ICU, cardiac stepdown units (medical and surgical), hemodialysis units, cardiac catheterization recovery, postanesthesia recovery, ambulatory recovery, and endoscopy suites, were cleared. Efforts to discharge patients from the floors and emergency departments were increased. Three hundred Saint Vincent's Hospital physicians, 100 nurses, and 500 other regu-



**Figure 2.** Proximity of level I trauma centers in Manhattan, NY, to the World Trade Center.

lar staff were mobilized and staged in the emergency department, rehabilitation gym, and operating rooms (**Figure 3**). Three hundred twenty-five nonclinical volunteers were similarly mobilized. Six overflow emergency treatment areas were established, and the Saint Vincent's emergency department was designated as the main



Figure 3. Awaiting casualties outside Saint Vincent's Hospital, Manhattan, NY.

**Table. Patient Population of Saint Vincent's Catholic Medical Center (Manhattan, NY) on September 11, 2001**

Type of Patients	No. of Patients (%)	Mean Age, y
Total	344	41.9
Males	235 (68.3)	42.2
Females	110 (31.9)	41.3
Pediatrics	5 (1.5)	
Geriatrics (older than 70 y)	15 (4.4)	

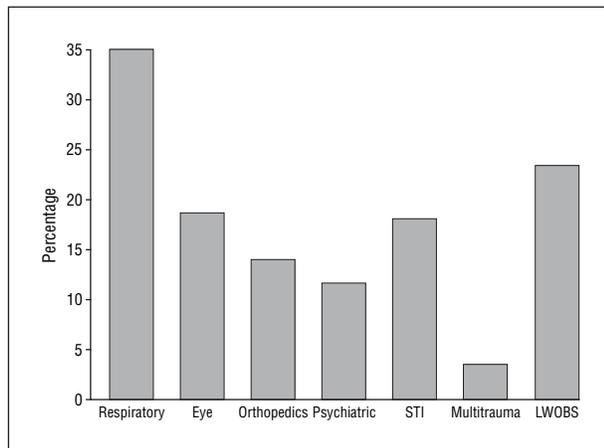


Figure 4. Distribution of injuries, September 11, 2001. LWOBs, indicates left without being seen; STI, soft-tissue injuries.

triage area. Senior surgical staff members were identified as triage officers. A command center staffed by hospital executives, department heads, and local police and fire officials was established in the Reiss boardroom on the ground floor of Saint Vincent's and staffed for 7 days.

Within 2 hours of the attack, blood donors assembled at Saint Vincent's were organized and bussed to collection sites and other hospitals (there were more than 500). Power, data, and electrical contingency plans were operating, and by this point, data lines (initially routed through the WTC) had been rerouted and were functional. Emergency generators and communications were similarly working, and water tankers to supply the hospital were provided by the city (water pressure was lost as a result of the disaster).

Within 3 hours, Saint Vincent's had procured additional supplies, in accordance with the hospital's major disaster plan; 18 000 pieces of burn linen, 300 oxygen tanks, 25 additional ventilators, 7500 burn packs, and 25 additional hospital beds were delivered. By this point, the logistical implementation of the disaster plan was complete. Communications, power, water, air conditioning, forced air ventilation, and suction had all been restored. Call centers were established, and family information areas and press contacts were established. Psychiatric and counseling services were arranged. Security forces were manned and ready. The physicians, nurses, and staff had only to await the arrival of the patients.

#### TIME FRAME OF PATIENTS' ARRIVALS

The first patient to seek treatment at Saint Vincent's from the terrorist attack came through the doors of the emergency department at 9:02 AM (Figure 1). Only 50 patients registered between 9:02 AM (the time of the first patient's arrival in the emergency department) and 12 PM. Over the next 3 hours (12 PM to 3 PM), 156 patients registered and were seen. Over the next 3 hours (3 PM to 6 PM), 48 patients were registered, and the last patient registered on September 11 did so at 11:37 PM (90 patients in approximately 6 hours). Of the 344 patients seen in Saint Vincent's Hospital on September 11, approximately 68% were male and 32% were female. The average age for males was approximately 42 years and the average age for females was approximately 41 years. The range of ages was from 0 years (3 patients; fever, breathing difficulty, and eye discharge) to 100 years (dust inhalation) (Table). Five patients were younger than 18 years, with complaints including back pain, wrist fracture, and dust inhalation (3 patients). Fifteen patients were older than 70 years, with complaints including breathing difficulty (9 patients), eye irritation (3 patients), abdominal pain, wrist fracture, and pacemaker failure.

#### DISTRIBUTION OF INJURIES

A total of 844 patients were seen in Saint Vincent's Hospital over the 3 days following the terrorist attack of September 11, 2001. This represented 14.5% of all admissions to emergency departments in the tristate area. Three hundred forty-four patients (40.4% of the total seen at Saint Vincent's) were seen between 9:02 AM on September 11 and 12:00 AM on September 12. Saint Vincent's Hospital emergency department saw the heaviest traffic of patients from the WTC attack of any hospital in New York City.

A review of the records indicated that the major cause of morbidity for the September 11, 2001, patients was smoke inhalation (30.0%), followed by chemical conjunctivitis and corneal abrasions (considered as 1 group, 16%) (Figure 4). Lacerations, abrasions, and soft-tissue injuries were 15.5% of the total patient population, and isolated orthopedic complaints (single fracture reduced in the emergency department or sprain) composed 12% the group. Psychiatric complaints were 10% of the total, and cardiac complaints were 8% of the patients seen (5 people had confirmed myocardial infarctions). Multiple-trauma patients (defined as a pa-

tient with blunt chest, abdominal, or head injury or with multiple fractures) were 3% of the patients seen. Forty-four patients (20%) left before being seen. There were 5 fatalities at Saint Vincent's Hospital. Many patients had multiple complaints (eg, dust inhalation and eye irritation) (**Figure 5**).

Forty-six patients were admitted for more than 24 hours. The last patient admitted on September 11 was released on September 17. Three patients were admitted and transferred to other institutions (all were transferred to the burn center at New York Presbyterian Hospital, New York). Seventeen patients were admitted for short periods of observation (<24 hours) and released on September 11.

### COST OF THE WTC ATTACK

The cost of the events of September 11, 2001, can never be measured. Thousands lost loved ones, and hundreds of thousands of lives were shattered. Countless businesses failed and the face of the city, as well as the entire nation, was forever changed.

In terms of responding to the initial events, the immediate response was only a small fraction of the cost to Saint Vincent's Hospital. Accounting for overtime to staff in the initial hours after the attack; security costs; emergency supplies, including durable goods and pharmaceuticals; and the cost of items lost or damaged in the incident, the total cost of the initial event was \$1.78 million.

However, travel in lower Manhattan was tightly restricted in the weeks and months that followed the attack. The closure of the 8 clinics operated by Saint Vincent's and the numerous physicians' offices located in the area, as well as most other businesses, led to a marked decline in patient visits for months to follow. Ambulatory surgery, faculty practices, primary care, and outpatient clinics also showed dramatic declines in patient visits. Taking these costs into account, the total cost of this attack to the Saint Vincent's organization totaled approximately \$10.8 million.

### COMMENT

The WTC disaster was a major source of morbidity and mortality to the people of New York City; although the mechanisms for the citywide response were in place and well administered, the hospitals of the City of New York are responsible for the training, development, and administration of their own (internal) major external disaster plans, which are then coordinated by the city agencies into a confederate citywide disaster response plan. This was the second response to an event at the WTC that was spearheaded by Saint Vincent's, but the 2 events could not possibly have been more dissimilar and some important lessons were learned as a result of the review of the hospital's response.

Saint Vincent's Hospital bore enormous responsibility to the people most acutely affected by the incident, and the possibility that Saint Vincent's will again serve in that role is in the forefront of the minds of everyone involved in updating our contingency plan. We identified a number of areas of weakness in our hospital's response protocols to a mass casualty incident (MCI). During the September 11 attack, the majority of patients had



**Figure 5.** The dust in the air near the World Trade Center on September 11, 2001, was so thick it is visible in this photograph.

respiratory complaints and eye irritation or minor eye injuries. The number of people requiring advanced trauma life support protocols was incredibly low. Only 3% of the patients evaluated at Saint Vincent's were multiple-trauma patients; although large numbers of burns, blast injuries, multiple-trauma patients, and head injuries were expected,<sup>1,2</sup> the great majority of patients that day were ambulatory, or "walking wounded."

Our expectation and preparations, since 1993, had been for the more traditional terrorist bombing. The reality in 2001 was a different constellation of injuries and injury patterns.<sup>1,2</sup> This distribution of injuries clearly was not what had been projected, and the drills that had taken place to this date had prepared the staff for a vastly different scenario. In the February 26, 1993, bombing, for example, the total number of people killed numbered 6, with more than 1000 injured, 169 seen in the emergency department, and 44 admitted to the hospital for more than 24 hours. Our drills prior to that point had centered on a similar scenario, preparing the staff for an array of different injuries on a continuum from severe to minor. On September 11, 2001, however, the lethality of the event was much more profound; the death toll stands today at 2996 (WTC only) compared with the 344 seen in the Saint Vincent's emergency department and 46 patients admitted for more than 24 hours. The distribution of injuries, in this case, was much more bimodal; either the injuries were lethal or they were minor. Only a few people had serious injuries that required trauma team use, critical trauma resources, advanced trauma life support protocols, advanced imaging techniques (computed tomography or fluorescent allergo-sorbent technique), or even hospitalization for more than 24 hours. Clearly, our preparedness for future events prior to September 11, 2001, relied on memory of historical events and not on a creative foresight into what might happen to New Yorkers in future times.

One of the most immediate and potentially dangerous complications of the urban bombing such as this one was the loss of communications and data. Phone lines were hopelessly jammed, and cellular service was similarly impossible to access. We learned the value of low-technology, older, but still reliable, back-up methods of communication, including messengers, tube systems, hard-wired intercoms, and FM-band walkie-talkies, all

of which were serendipitously available on September 11, 2001.<sup>3</sup> As a result of this experience, we have instituted a system whereby disaster drills are no longer straightforward arrivals of moulaged patients through our emergency department. Instead, the element of chaos, always present in MCIs, is purposefully injected into drills for the sake of testing resources, flexibility, and creativity of the response team. In the case of communications, contingency plans for laboratory reporting, radiology reporting (for hospitals equipped with electronic radiograph storage and retrieval systems, for example), and physician-to-physician communication need to be tested, for example, during drills so that the plans would be reasonably familiar to staff and there would be a standard protocol that would be known and followed during such a situation.

Additionally, it is not only the in-hospital, clinical personnel who are affected by data and communications losses. Hospital security, for example, can be potentially crippled by the loss of high-technology components, like video surveillance, telephone and cellular communications, and computer contact. Older FM-band radios are reliable and provided a much-needed backup link during the early hours after the disaster. Hard-wired intercoms and tube systems were essential both to patient care and other administrative functions during that time.

Prehospital communication with Saint Vincent's was also affected when telephone, cellular, and electrical lines were lost. Although emergency medical services (EMS) was able to communicate with its forward elements by radio, and police, fire departments, and EMS were able to communicate with each other both by radio and through the city's command post, communication from forward EMS elements to the hospital was disrupted. Police, fire, and EMS personnel were present in the hospital; this, coupled with the command post located in the hospital, facilitated prehospital communication with Saint Vincent's, which would have otherwise been lost.<sup>4</sup> By the time electricity and telephone service had been restored, communication lines were operational both by telephone and through the EMS, police, and fire departments' representatives within Saint Vincent's.

Power contingency plans were already in place and emergency generators were operational when power was lost to the hospital, but staff training with respect to use of resources and how to access critical energy sources is similarly important and was mostly overlooked prior to this incident. Additionally, staff training on patient care tasks requires a different approach during power outages; the concept of minimally acceptable care,<sup>5</sup> especially given the projected volume of patients on September 11, 2001, was discussed, and its implementation was not necessary. It, however, will be part of staff development and training for MCIs in the future.

Water pressure contingencies were not part of the hospital's major disaster plan, but they were part of the city's disaster contingency plan. The loss of hospital-based suction was a surprise; it had never happened before. Water tankers were provided to the hospital and suction was quickly restored, but their loss was a source of consternation in the early hours after the attack. Portable devices adequately served those in house who needed suction, but the supply of portable electric machines was short and had

the demand been higher or the gap in suction availability longer, the hospital would have been in dire straits in this regard. As with previous component failures, these elements have been introduced into the regular disaster drills at Saint Vincent's as a way to inject chaos into the drill.

As a result of the WTC attack, and the subsequent terrorist threats, including dirty bombs, nuclear weapon use, anthrax and smallpox as biological weapons, and drinking water contamination, we now have in place organized and appropriate potential responses to possible nuclear, biological, or chemical attacks.<sup>6,7</sup> Our renovations to the trauma center at Saint Vincent's will include expanded decontamination facilities, and our training and staff development includes segments on nuclear, biological, or chemical warfare and decontamination. We have established and trained nuclear, biological, or chemical decontamination teams, and the protocols have been circulated to departments within the hospital for subsequent staff training. The contamination of resources and spaces in the hospital by early patients exposed to nuclear, biological, or chemical warfare agents remains a real possibility and is another variable that might be used in future disaster drills to test the flexibility and creativity of the disaster preparedness system at Saint Vincent's.

On that note, the most important trial to our disaster response was that most patients bypassed formal EMS triage and arrived at the Saint Vincent's emergency department on foot (ambulatory). Once triaged at Saint Vincent's, they were sent to 1 of 6 areas in the hospital for treatment or further evaluation. The bypass of EMS triage was a serious strain on the manpower and other resources of the hospital, but because most of the patients were walking wounded with relatively minor injuries, they were treated and released instead of being transported to other hospitals, as they would have had they gone to the formal EMS triage.<sup>6</sup> Triage of ambulatory patients of these numbers was never planned or drilled during our disaster preparation. This is the equivalent of an astronomical overtriage rate of perhaps as much as 89%; only 3% of patients were multitrauma, and only 8% had cardiac complaints. Were a city agency or EMS responsible for such a rate of overtriage, it would have been identified as a critical area for further training and testing. As it happened, however, the patients self-triaged to Saint Vincent's. We have learned that a primary triage, at the door to the emergency department, is essential at rationing critical trauma resources for more critically injured patients during future events. No adverse outcomes were linked to the overtriage rate on September 11, 2001, mostly because of the previously mentioned bimodal distribution of injury lethality. Patients with only minor injuries could have been diverted to other city hospitals and likely would have been had there been any real strain on the trauma resources at Saint Vincent's at all. Irrespective of that, plans are now in place for diversion of patients with minor injuries regardless of their mode of arrival in future incidents.

Surge capacity was an area of the disaster response that had been adequately drilled and prepared.<sup>6</sup> Staff in the critical areas were familiar with the plans to increase the capacity of critical care-capable (monitored) beds and knew which areas would be used and for which purposes. However, there were a few logistical details that did not become apparent until the bombings. Although the ambulatory and endos-

copy recovery rooms have the monitoring capabilities to be used as critical care areas, they did not have the available appropriate adjunctive equipment readily at hand. Pressure bags, transducers, cuffs of varying sizes, tubing of various types, and sizes and different kinds of cables were in short supply in these overflow areas, and only a key few people knew where the extra supplies were kept. Ambulatory recovery rooms and hemodialysis units, which usually had reclining chairs, had to be supplied with beds or stretchers, which meant fewer beds and stretchers for other uses (ie, emergency department). Disaster drills usually involve only key personnel and the emergency department and occasionally the operating rooms. From this experience, we have learned that occasionally incorporating other areas of the hospital, either in the capacity of actually converting the space to a critical care area or, for example, converting the rehabilitation gym into an overflow emergency department, again injects the small needed element of chaos into the drills. Often, during the day, it is difficult to set aside the daily routine to perform a disaster drill but when an actual event occurs, the dividends of the hours spent in drills are large.

September 11, 2001, also taught us that even in one of the most populated areas of the world, food, water, and other basic supplies might still run short in times of disaster. We have established strategic supplies of key basic necessities, including potable water, fans, cots, and certain pharmaceuticals, to be independent of city resources for a short period. We have established relationships with local supermarkets and merchants for short-term help in times of most need. This is essential, especially in the event of a future, similar disaster because were city resources affected by the attack, Saint Vincent's would not have had access to critical rations of pharmaceuticals, food, and water necessary for patient care for several hours.<sup>2</sup>

We also found it necessary to enhance provisions for families and others looking for missing or injured loved ones. Mechanisms and logistics are now in place to again undertake a prolonged and large-scale relief effort directed toward families and dissemination of information. Families inundated Saint Vincent's with calls and visits to the hospital looking for loved ones. Not only does the physical space for a call center need to exist, but the extra phones and phone lines need to be planned for and the staffing and training of volunteers and nonclinical employees needs to take place. Similarly, reasonably rapid flow of information needs to occur so that families and press can get swift and accurate data from inside the hospital. Additionally, agreements with other institutions or companies may need to be in place prior to such an event. In our case, one of the nearby colleges donated space for the call center and an agreement for future use of the space, if necessary, is in place.

Although agreements with nearby hospitals are often in place for transfer, if those protocols are not frequently used, the exact mechanisms are often unknown at the time of an event. Tabletop disaster drills are useful for analyzing transfer arrangements and agreements for this purpose and serve to familiarize key personnel with the details of those agreements.

A critical review of all aspects of the hospital's response to the disaster took place in the months that followed September 11, 2001.<sup>1</sup> None of the inefficiencies or shortcomings of the disaster plan as it existed on September 10, 2001,



Figure 6. Post-September 11, 2001, tribute in lights.

resulted in an adverse outcome. However, the potential for the hospital to be caught unawares on many different points, only a few of which were discussed earlier, was recognized. The changes made to the disaster response system at Saint Vincent's will address some of the most critical areas of deficiency. Most important to the long-term ability of a hospital to respond to disaster is the ability to review and adapt to the environment. Chaos is a part of every MCI and should be made part of every MCI drill.

The total cost to the institution was approximately \$10.8 million. It is difficult to recoup the monetary losses incurred by the disaster, and the hospital is working to overcome the financial strain even 4 years later. State and federal agencies have awarded grants and private citizens have donated money to help defray the costs of caring for the disaster patients. Although by now, Saint Vincent's is almost back to business as usual, the emotional toll continues to be measured. The people of New York, and, indeed, the world, for the foreseeable future, are still looking over their collective shoulder, still stockpiling supplies, and still, even now, planning for the worst (Figure 6).

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