Blackout 2003: Preparedness and Lessons Learned from the Perspectives of Four Hospitals

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Abbreviations:
EMS = emergency medical services
EOC = emergency operations center
IRB = institutional review board
JACHO = Joint Accreditation of Healthcare Organization
UN = United Nations
US = United States
WHO = World Health Organization

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Abstract

Introduction: The blackout in North America of August 2003 was one of the worst on record. It affected eight US states and parts of Canada for >24 hours. Additionally, two large US cities, Detroit, Michigan and Cleveland, Ohio, suffered from a loss of water pressure and a subsequent ban on the use of public supplies of potable water that lasted four days. A literature review revealed a paucity of literature that describes blackouts and how they may affect the medical community.

Methods: This paper includes a review of after-action reports from four inner-city, urban hospitals supplemented accounts from the authors' hospital's emergency operations center (EOC).

Results: Some of the problems encountered, included: (1)lighting; (2) elevator operations; (3) supplies of water; (4) communication operations; (5) computer failure; (6) lack of adequate supplies of food; (7) mobility to obtain X-ray studies; (8) heating, air condition, and ventilation; (9) staffing; (10) pharmacy; (11) registration of patients; (12) hospital EOC; (13) loss of isolation facilities; (14) inadequate supplies of paper; (15) impaired ability to provide care for non-emergency patients; (16) sanitation; and (17) inadequate emergency power.

Discussion: The blackout of 2003 uncovered problems within the US hospital system, ranging from staffing to generator coverage. This report is a review of the effects that the blackout and water ban of 2003 had on hospitals in a large inner-city area. Also discussed are solutions utilized at the time and recommendations for the future.

Conclusion: The blackout of 2003 was an excellent test of disaster/emergency planning, and produced many valuable lessons to be used in future events.

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Introduction

On 14 August 2003, the North East-Central area of the United States within the distribution of the Niagara electric power grid, experienced a major power failure. At 16:03 hours, a blackout began in Ohio and expanded, effecting northern Ohio, New York, Massachusetts, Pennsylvania, Vermont, New Jersey, Connecticut, Michigan, and parts of Ontario, Canada. Return of power began within 12 hours, and was restored fully into all areas within 72 hours. Additionally, Detroit lost water supply to the affected facilities for >24 hours. Following the restoration of power, Detroit experienced a ban on the drinking of municipal tap water for an additional 72 hours. As would be expected, the public health system was placed under significant strain. Emergency medical services (EMS) experienced a large increase in emergency call volume, emergency departments saw an increase in patient volume, and hospitals noted an increase in cafeteria use. A literature review of the topic revealed a paucity of published articles regarding blackouts and hospitals. This article is a case report of four hospitals' experiences, lessons learned, and solution options from experiences during the blackout of 2003.

Methods

Three emergency medicine physicians who are knowledgeable in disaster preparedness and response reviewed the after-action reports from four urban, inner-city hospitals: two Level-I trauma centers, one children's hospital, and one Level-II trauma center. The range of annual emergency department visits is 70,000–90,000 patients with an annual urban EMS call volume of >100,000. The population of the area is 1.2 million people. Information was gathered using informal interviews with hospital staff who were present during the blackout, from personal experiences of the authors present at hospital emergency operation center (EOC) meetings during the blackout, and from written after-action reports. All hospitals involved have an emergency medicine residency program, are accredited by the Joint Commission on Accreditation of Healthcare Organization (JACHO), and have active emergency preparedness groups, which have been meeting since 1999. In order to protect source confidentiality, identifying hospital information was not used in any descriptions. This project has been exempted from review by Wayne State University's Institutional Review Board.

Results

Despite the lack of potable water, limited emergency imaging capabilities, and staffing issues, all area hospitals were able to provide adequate patient care for the duration of the blackout. Each of the hospitals activated its individual EOC. After-action reports noted multiple communication difficulties including intra-hospital, inter-hospital, and with the city, county, and state EOCs (Table 1). Despite public service announcements in multiple languages via the radio, television, and newspapers that asked people not to call 9-1-1 for an ambulance unless there was a true medical emergency, there was a large influx of non-life-threatening 9-1-1 calls for EMS. These included 9-1-1 calls by the elderly or able-bodied people for potable water and food, but also reassurance from people they trusted. Many of the non-urgent patients transported by EMS to emergency departments, as well as those who arrived to emergency departments by personal vehicle came for various reasons, including: (1) a lack of sufficient home medications; (2) no backup home oxygen for patients who required oxygen; (3) no reserve batteries for home oxygen concentrators; and (4) no emergency power sources for home or nursing home ventilators.

Other issues from after-action reports describe internal electrical problems, despite generator use, which affected elevators, air conditioning, and refrigeration not only for plug-in units, but also to building areas such as the cafeteria and morgue (Table 2). Also mentioned as a "large" problem were "just in time" inventory issues such as food and linens for in-patients since the emergency outlasted the 24-hour supply the hospitals normally carry. Additionally, cafeteria management noted that there was a surge in the number of cafeteria meals served due to the influx of hospital employee family members and the general public who came to the hospital because the food was fresh and available.

• No up-to-date contact lists were available for physicians and hospital staff
• Hospital pagers did not function if they had been "transferred/signed over" to another pager
• Cell phone reception was sporadic
• Computer intranet/Internet access was not available at each of the hospitals, due to routers being down
• Sporadic emergency information from the hospital EOC to hospital employees resulted in rumor control issues
• EMS trunked communication system was not functional

Table 1—Communication problems noted during the Blackout 2003 (EOC = emergency operation center; EMS = emegency medical services)

For 96 hours, the availability of potable water and adequate water pressure became a very important issue. During the first two hours, there was a lack of water pressure for the hospitals and the region. This affected the ability to flush commodes, wash hands, sterilize instruments, develop radiographs, and provide air conditioning, as there was no water pressure to get water to the air conditioning condensers (Table 3). Hospitals with digital X-ray systems did not have the power to display images on picture archiving and communication systems, so physicians had to view images on the acquisition system or the radiology services had to use chemical developing tanks to manually develop X-rays. Normal saline and sterile bottled water was used for hand washing. Until power was restored fully, the lack of water pressure hindered the flushing of commodes and caused a huge problem with human waste. This was rectified when water was poured into the toilet bowl to flush the waste. When city water pressure was restored, the local health department expressed concern that the tap water was not potable and would require microbiological testing for coliform levels, which could take up to 72 hours to complete. This resulted in a city and regional ban of potable water for 96 hours for citizens and institutions using the municipal water supply system. Many of the hospitals did not have extra bottled water on-site; however, one hospital, due to its planning for Y2K, had extra pallets of bottled water stored in the basement. Other hospitals had the city's EOC contact the local National Guard for water, which was delivered approximately 36 hours after the request. This took care of drinking water issues, but did not address issues such as the need for water required for dialysis.

In the weeks after the blackout, hospital emergency management groups began reviewing after-action reports and made suggestions to upper management regarding infrastructure problems and solutions. The areas identified and recommended solutions are presented (Appendix). The suggestions were direction towards alleviating some of the problems encountered in: (1) lighting; (2) elevator operations; (3) supplies of water; (4) communication operations; (5) computer failures; (6) lack of adequate supplies of food; (7) mobility to obtain X-ray studies; (8) heating, air conditioning, and ventilation; (9) staffing; (10) pharmacy services; (11) registration of patients; (12) hospital EOC; (13) loss of isolation facilities; (14) inadequate sup-

- Computer networks off-line
- Laboratory interconnects off-line
- Radiology system off-line either due to a lack of power or computer problems
- Internet/intranet servers unavailable
- Computed tomography (CT) scanner without a dedicated back-up generator
- Majority of elevators non-operational
- One emergency department lost most of its lights
- Unable to pump fuel
- Pharmacy unable to access Pyxis© system
- Morgue not on auxiliary power
- Pharmacy refrigerators not on back up power
- Loss of negative pressure in isolation rooms

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Table 2—Hospital electrical issues

plies of paper; (15) impaired ability to provide care for non-emergency patients; (16) sanitation; and (17) inadequate emergency power.

Discussion

The blackout of 2003 illustrated many of the disaster/emergency problems that are repeatedly identified and documented in after-action reports. For example, a review of general disaster literature demonstrates that communication avenues often fail.[1,2] This held true during the 2003 blackout: almost every after-action report mentioned internal and external communication as a major problem, including failures of pagers, cell phones (not land lines), and inability to access the Internet. Post-incident emergency/disaster committees mentioned that while an accepted hospital policy of "just in time" inventory works in a normal environment, it is not well-suited for use in an emergency/disaster situation. Hospital emergency planners must remember that when an emergency/disaster strikes, the hospital must be self-sufficient for 48–72 hours. Areas identified that were not self-sufficient included: linens, water, food, disposable medical supplies, sterilization for reusable supplies, dialysis, X-ray developing, and fuel for both emergency generators and security vehicles.

Issues regarding the lack of running water were resolved partially with waterless hand wash dispensers that were distributed during the event; this created a change in hospital policy that now requires that these dispensers are available and kept in-stock. Another major problem was related to the extra "non-acute" patients who arrived from home and long-term care facilities that do not have emergency generators and ventilation systems. The influx of patients requiring support was managed by setting up ventilators and non-acute care areas that could be managed by nursing staff after a physician had performed an initial assessment. Additionally, although each hospital had its own EOC, there was no official citywide or area-wide hospital EOC to allow unique hospital problems to be discussed and answers shared. Although it is in the emergency plans for a hospital representative to be in the city EOC, the designated person was out-of-town and there was no backup available. For example, one of the hospitals experienced inadequate generator power and, after the blackout,

- Sterilization equipment needed water
- Cafeteria needed water for steaming and cooking
- Computed tomography (CT) scanners and other equipment needed water for cooling
- Heating, ventilation, and air conditioning (HVAC) systems needed a water system for cooling and heating
- Some X-rays needed water for processing
- Toilets were not flushable
- Personal hygiene: Unable to wash hands or equipment
- Unable to run certain laboratory tests/equipment

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Table 3—Water issues encountered

- Extra medication (at least a 1-week supply), and if necessary, a way to keep chilled
- First-Aid kit
- Bottled water- enough for 3 days, 4 liters per person per day
- Spare eyeglasses or contact lenses with cleaning solution
- Canned and dried food for 7 days
- Non-electric can opener
- Pet food if appropriate
- Flashlight with extra batteries
- Portable AM/FM radio with extra batteries
- Appropriate seasonal clothing
- Essential personal hygiene items
- Wet Wipes® for personal hygiene
- Toilet paper
- Keep fuel tank for car full
- If you or family uses home oxygen have a spare tank available and emergency contact numbers
- Emergency meeting/contact plan for family

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Table 4—Personal disaster preparation

it was discovered that another hospital in the region had a pre-existing contract for backup portable generators. Had this information been available at the time it was needed, the hospital with the contract could have provided service to the hospital in need.

In the review of the after-action reports, many of the emergency department patient problems could have been solved by an experienced social worker, for example: telephone numbers for emergency home oxygen delivery could be distributed, a list of pharmacies that were open could be shared, and transportation services that could help bring patients to and from the hospital without utilizing ambulances could be publicized.

There also were many other issues that could have been avoided with some forethought and planning, including: (1) computers, lights, rechargeable batteries, and pharmacy refrigerators were not plugged into red emergency outlets, and were not functional; and (2) Internet/intranet capabilities were not lost because the main server went down as originally suspected, but rather because computer routers were not plugged into emergency outlets to allow computers to communicate with the main server in a different location. Remarkably, there were very few issues noted that were related to staffing. Most hospitals held staff until the next shift arrived; but most staff issues were related to child/elder care requirements, lack of public transportation,

or a lack of fuel in personal vehicles. To help staff membres prepare for future events, some of the hospitals have made a list of personal emergency items available to staff (Table 4).

Conclusion

The blackout of 2003 was an excellent test of disaster/emergency plans and a wake-up call to the reality that emergencies do not always happen in isolation, and more than one event can transpire at the same time, i.e. losing both power and water. In the area of the blackout, many physical plant problems were identified, and as other issues were recognized. Emergency/disaster planners must be aware of this information and should dedicate time and resources toward mitigation and preparedness endeavors that may lessen the impact in another such crisis when it arises.

References

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Issue	Suggestions
Lighting	
Ambient lighting decreased while on emergency power	Supply a sufficient number of flashlights and extra batteries Maintain stocks of batteries and extra flashlights/headlamps
Insufficient number of procedural lamps available	Consider use of headlamps for local procedure lighting, i.e., emergency department suturing
Overhead light sources did not work	Verify that emergency lighting is available in ALL patient care areas
Elevators	
Most elevators were not powered	Verify that at least one elevator capable of transporting a stretcher will function on generator power
People were trapped in elevators	Verify ability of staff to evacuate elevator passengers
Water	
No potable water	Need 1 gallon (4L) of water per person per day of potable water for 2–3 days; ICU and burn patients may require more Know alternative water sources: National Guard, Red Cross, local/county emergency management
No water pressure	Create plans for management of dialysis patients Have alternate plans for equipment sterilization if system uses water
Communications	
Cellular telphone system down or having problems	Have power failure phones easily identified Landline system was up, need direct connect phones and phone numbers
Pager system down	Verify overhead paging will work on emergency and generator power Some pagers have outside direct contact numbers for each unit Create a list of 10-digit pager numbers Need current contact information for all staff and physicians that is NOT Internet/intranet dependent Consider a notification phone tree Physicians on-call should have a pre-assigned emergency hospital call-in number Do not rely on the Internet/intranet for phone/pager numbers; keep an updated hard copy or compact disk
EMS notification radio not functioning	Have alternatives for EMS to contact ED with patient information (Dedicated "landline" notification) Develop plans for local radio stations to carry staff information, identify stations to staff prior to disasters/emergencies, have the station printed on the employee's badge Develop relationship with Amateur Radio Operators (RACES, ARES)
Computers	
Network off-line	Local computers, printers, and interfaces must be on emergency power outlets
Laboratory interconnects off-line	Have downtime software on system for discharge instructions
Radiology system off-line	Have a system in place in which X-rays can be developed using chemicals
Internet access off-line	Routers must be connected to emergency power
Servers off-line	Make sure servers are connected to emergency power
Food	
Inadequate supplies	Maintain 3-day supply of food for patients and all staff Expect to feed staff for free for the first few days Make sure the disaster plan includes the cafeteria employees as essential personnel Create tray transport alternatives if elevators are not working Consider food sources for EMS personnel
Radiology:	
CT scanners down	Verify one CT scanner is connected to emergency power and has its own cooling capabilities
X-ray not on backup power	Make sure there is one chemical method of X-ray developing available Develop ability to process films manually Verify ability of digital radiography system to work on emergency power, including display systems Utilize portable X-ray equipment for all essential studies
Water needed for developing X-rays	Ensure radiology department has efficient water supplies for developing

Appendix—After-action report blackout issues and suggestions for planning, mitigation, response, and recovery (ED = emergency department; EMS = emergency medical services; ICU = intensive care unit; AC = air conditioning; HEICS = hospital emergency incident command system; CT = computed tomography) *continued*

Issue	Suggestions
Heating, ventilation, air conditioning (HVAC)	
Loss of water, No AC available	Memo of Understanding (MOU) with vendors for portable AC units
Limited ventilation	Have fans available
In winter, heating could be a problem	Provide options for heating units, must be able to work using emergency power source
Laboratory equipment overheated	Ensure all essential laboratories are cooled/heated adequately to allow essential equipment to operate
Staffing	
Lack of staff communications	Regularly update staff on disaster plans
Lack of public transportation	Develop plans for shuttling staff who use public transportation
Lack of fuel	Encourage staff to keep vehicle fuel tanks half-filled
Lack of childcare/eldercare	Have in disaster plan a contingency plan for employees and their families Ensure that staff knows you will help take care of their immediate families, so that they will come to work
Pharmacy	
Pyxis® and similar systems off-line	Verify Pyxis® system is connected to emergency power and has battery backup
Loss of power to pharmacy refrigerators	Ensure all refrigerators are connected to emergency power
Patients were discharged without ability to get medications	Essential medications should be dispensed for two days for all patients discharged from the ED or hospital Medications that should be kept cool/warm should be labeled and packaged appropriately and sent with the patient
Patient Registration	
Computer registration down	Make sure computers and routers are connected to emergency power Provide a computer downtime system for patient registration Maintain sufficient paper off-line supplies for three days
Hosiptal Emergency Incident Command System (HEICS)	
Lack of incident command system	Have plans for Incident Command Structure and drill with upper management so they understand their roles and how the system works
Lack of procedural knowledge	Ensure plans are easy to follow, located at each nursing station and in ED
"Essential" command personnel not available	Develop plans with quick look-up information Keep accurate phone numbers Have an emergency plan book with helpful hints and lessons learned Have middle and upper management drill a few times per year Have established emergency relationships with vendors Assign people down the command chain to command HEICS roles to allow them to practice
Medical	
Loss of isolation rooms	Ventilation systems in all isolation rooms need battery backup and must be connected to emergency power Portable HEPA filters and necessary supplies so as to be able to create an isolation room
Paper charting for discharging patients	Have paper charting ability when dictation/computer system is down
Patients	
Decrease non-acute patient volume	Ask the media to suggest to the public that they utilize hospitals only for real emergencies
Influx of vented and home oxygen patients	Prepare ward area for home vented and home oxygen patients who lose power Limit use of laboratory testing and X-ray for essential tests only Streamline admissions to the floor Keep patients and families informed Limit visitors and hours Utilize volunteers early Utilize social workers for assistance with pharmacy medications, home oxygen delivery, etc.

Appendix—After-action report blackout issues and suggestions for planning, mitigation, response, and recovery (ED = emergency department; EMS = emergency medical services; ICU = intensive care unit; AC = air conditioning; HEICS = hospital emergency incident command system) *continued*

Sanitation	
Loss of water pressure = loss of toilets	Need source for portable chemical toilets for staff use as well as plans for the dumping of patient waste
Potential lack of garbage pick-up	Pre-arrange garbage pick-up
Generators	
Potential breakdown	Consider 2–3 generators, there should be one more than needed regularly to anticipate breakdown and cycling needs
Unable to run at full capacity to reserve fuel	Have pre-determined fuel sources with agreements signed Acquire generator equipment to meet and exceed needs Provide sufficient fuel for several days Test all generators monthly, know how much power each can generate

Appendix—After-action report blackout issues and suggestions for planning, mitigation, response, and recovery (ED = emergency department; EMS = emergency medical services; ICU = intensive care unit; AC = air conditioning; HEICS = hospital emergency incident command system)