

EDITOR'S Q&A

Appendix 1. Reports of intraoperative power failure. Abbreviations: OR – operating room; PACU – post-anesthesia care unit; ESU – electrosurgical unit; ICU – intensive care unit; CABG – coronary artery bypass graft; CPB – cardiopulmonary bypass; ACT – activated clotting time; TOF – train-of-four; TIVA – total intravenous anesthesia.
[†]Year of publication.

Year [†]	Scenario	Root Cause	Outcome	Recommendations
2010	<ul style="list-style-type: none"> Complete loss of power on two consecutive days 9 operations in progress Outage lasted 13 minutes on day 1 and 9 minutes on day 2 	<ul style="list-style-type: none"> Fault within the switching panel that controlled whether the hospital used municipal power or emergency generator power Unclear if generators worked 	<ul style="list-style-type: none"> Anesthesia monitors failed and “clinical monitoring” was used until portable transport monitors arrived Video towers and imaging systems failed Surgical lights, ventilators, gas delivery systems and CPB continued because of built-in batteries 	<ul style="list-style-type: none"> An uninterruptible power supply system for the OR should be installed as this would allow at least one hour of power in the ORs in order to complete ongoing procedures Staff should be familiar with power requirements of equipment⁵
2010	<ul style="list-style-type: none"> Partial hospital power failure with loss of power to emergency (generator) system 8 operations in progress, including a craniotomy, Whipple procedure, and kidney transplant Outage lasted 15 minutes 	<ul style="list-style-type: none"> During construction, a phase loss relay in main hospital circuit became dislodged, simulating loss of municipal power A critical branch transfer switch then connected hospital power to an emergency generator that was disabled for servicing “Red outlets” that were supplied by generator lost power 	<ul style="list-style-type: none"> Most anesthesia providers switched to manual ventilation, while two continued to use the battery-powered anesthesia machine ventilator 3 providers switched from desflurane to sevoflurane or isoflurane. One switched to propofol infusion with midazolam All patient monitoring was interrupted except in the one room where anesthesia equipment was erroneously not plugged into red outlet. Portable monitors were brought into rooms Room lights continued to function except in one room ESUs and automated drug supply cabinets failed 	<ul style="list-style-type: none"> Communication should be improved by notifying staff of potential power loss during possible service interruption and developing a “batch paging” system to notify key personnel during an emergency Anesthesia providers should focus on “ABCs”, call for help, utilize emergency equipment and ensure delivery of anesthesia to the patient All rooms should have portable backup lights If some equipment is functional in a room, consider plugging failed equipment into different outlets Phase loss relay component should be secured to avoid a similar accident in future⁶
2005	<ul style="list-style-type: none"> Complete loss of hospital power Emergency generators failed in wing of hospital with operating room, but functioned elsewhere Complex oral and maxillo-facial operation in progress Outage lasted days 	<ul style="list-style-type: none"> Multistate power outage (Northeast blackout of 2003) 	<ul style="list-style-type: none"> Room lights failed Anesthesia machine display and monitors worked, but ventilator bellows could not be seen in the dark TIVA initiated. Patient ventilated with self-inflating resuscitation bag and tank oxygen Once portable lights confirmed normal bellows function and pipeline gas supply, anesthesia machine resumed ventilation with volatile agent Operation was suspended, patient was left intubated and transported to PACU Operation completed the next day in a different building which had generator power 	<ul style="list-style-type: none"> Anesthesiologists have a critical leadership role in the OR during crisis. Clear communication and thoughtful planning are key to avoiding panic Daily equipment checks should include flashlights and batteries in every room The battery life of anesthesia equipment should be determined Consider resuming spontaneous ventilation under anesthesia as a safety precaution in case anesthesia machine battery fails⁷
2001	<ul style="list-style-type: none"> Complete loss of hospital power 3 operations in progress: ankle fusion, pelvic extension, and radical neck dissection Outage lasted >1 week, requiring evacuation of all hospital patients 	<ul style="list-style-type: none"> Fire in electrical vault Electricity still supplied to building by municipal power but unable to be distributed throughout hospital Main and backup generators destroyed by fire 	<ul style="list-style-type: none"> Flashlight used for light source in ORs Anesthesia machines continued to function on battery Wall suction failed and portable suction unit used Electrosurgical units failed and battery-powered bipolar eye electrosurgery units and vessel ligation were used to achieve hemostasis Automated drug supply cabinets failed All operative procedures were near completion and incisions were closed 	<ul style="list-style-type: none"> Create emergency staffing plan that identifies specific staff member responsibilities and roles Battery operated ESUs and suction should be available Perform mock disaster drills quarterly Pharmacy services should have a plan to ensure availability of medications to operating rooms Flashlights and paper intraoperative records should be available in ORs⁸
2000	<ul style="list-style-type: none"> Complete loss of hospital power Both emergency generators failed Carotid endarterectomy in progress Outage lasted 30 minutes 	<ul style="list-style-type: none"> Construction workers accidentally drove a steel pile through the hospital’s main incoming power cables The first generator did not start at all. The second generator started, but was quickly overloaded and then failed 	<ul style="list-style-type: none"> Room lights failed except for one light with a back-up battery Anesthesia machine ventilator continued to function Patient monitors failed, including gas analyzer and capnography. Surgeon watched pulsations of the carotid artery until a portable monitor was available Capnography and agent monitoring remained unavailable The case was aborted, and the patient was taken to the ICU 	<ul style="list-style-type: none"> Emergency generator planning should take into account the load placed on one generator in case a second generator fails⁹
1995	<ul style="list-style-type: none"> Complete loss of hospital power Ongoing cardiac case with patient on CPB Outage lasted 53 minutes 	<ul style="list-style-type: none"> Loss of municipal power during heat wave Emergency generators started, then failed after 15 minutes 	<ul style="list-style-type: none"> Room lights, CPB machine, communications (intercom, pager), patient monitors, and suction failed Roller head in CPB circuit was manually cranked to maintain a venous saturation > 70% Flashlights and laryngoscope lights were used for illumination Portable monitors and suction brought to room Measurement of ACT performed manually with flashlight and stopwatch Not possible to rewarm patient. Came off CPB on dopamine. CPB reinstated when power restored 	<ul style="list-style-type: none"> Hand-cranking a CPB machine is exhausting, and relief staff must be brought in for this purpose immediately The capabilities of various functions of the CPB machine and battery life must be determined in advance of a crisis When communications fail, all available anesthesia personnel should systematically check each OR to determine priority needs Battery powered lighting in hallways, workrooms and PACU is also necessary to find equipment and prevent staff injury Staff in ORs must be assessed periodically for heat exhaustion when air conditioning fails during a heat wave¹⁰
1993	<ul style="list-style-type: none"> Operating room loss of power. No mention of other hospital areas Ongoing laparotomy Emergency generators worked for approximately 3 minutes, then failed Outage lasted 45 minutes 	<ul style="list-style-type: none"> Regional power outage (likely Hurricane Hugo) Generator cooling system had been accidentally deactivated. When the generator activated in response to the power failure, it quickly overheated and failed 	<ul style="list-style-type: none"> All lighting, ventilator and monitors except for pulse oximeter failed Ventilation was continued manually via anesthetic circle system Portable monitors were used, including manual BP cuff, esophageal stethoscope, TOF monitor, oxygen analyzer, pulse oximeter and EKG Flashlights used, but inadequate for continuation of surgery. When power returned 45 min later, surgery resumed 	<ul style="list-style-type: none"> Clinicians should be ready to use manual monitors and physical exam to monitor patients if battery-powered devices fail Develop a plan for OR power outage and rehearse it¹¹