

Preparing for Total Power Failure in the Operating Room

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Total electrical power failure in the operating room is an uncommon event, but when it occurs, it poses a major threat to patient safety. Perhaps the most curable threat to patient safety is the lack of provider knowledge regarding what equipment capabilities will be lost and how long devices will function on battery power. The purpose of this project was to determine the internal battery-related capabilities and duration of function of site-specific anesthesia equipment during a total power failure and to develop a power failure protocol. Equipment capabilities and duration of function on internal battery power were assessed for several anesthesia gas machines (AGM), vital sign monitors, and intravenous infusion pumps. Testing revealed

substantial differences in AGM battery life compared with the manufacturer's reference values. Vital sign monitors integral to the AGM failed immediately on simulation of a power failure, whereas portable vital sign monitors and infusion pumps functioned, on average, for 150 and 270 minutes, respectively. Because many devices relied on in the operating room do not operate or have reduced functional capability during a power failure, it is important to have a site-specific protocol to optimize patient care decision making in the event of a total power failure.

Keywords: Anesthesia, anesthetic equipment, operating room, power failure.

Anesthesia providers rely on sophisticated electrically powered equipment such as the anesthesia gas machine (AGM) and associated monitors to safely care for their patients. Although loss of electrical power in an operating room is a rare occurrence, it presents a grave threat to patient safety when it occurs. Critically important pieces of anesthesia patient care equipment responsible for maintaining and monitoring the patient's vital functions require a continuous supply of electricity to operate. Even though medical facilities have backup generators to supply electricity if they lose primary electric power from the supply grid, case reports have shown that backup generators are not infallible.¹⁻¹⁰ Holland et al¹¹ have noted that even a brief electrical interruption can cause critical equipment to reboot and delay patient care for several minutes, and therefore patient safety is compromised any time power fails in the operating room. Although critical pieces of anesthesia-related patient care equipment can operate on internal battery power if the main and backup generator electrical power are lost (ie, total power failure), the capabilities and duration of operation of specific local devices is largely unknown among anesthesia providers.¹² According to published reports, anesthesia providers' responses to power failures in the operating room are variable and may be inappropriate for the situation.¹¹ Anesthesia providers need to understand

the capabilities of their equipment during a power failure and consider the implications a power failure could have on their ability to provide patient care.¹¹ Prior thought should be given to, and preparations made for, operating room total power failure because of the major threat such an event poses to patient safety.

At the commencement of this project, there was no anesthesia departmental plan or protocol in place regarding what specific actions or modifications to patient care should be considered during a total power failure in the operating suite. The primary purpose of this project was therefore to determine the backup battery-related capabilities and duration of function of the site's anesthesia equipment and to use this information to develop a patient care protocol for total power failure. A secondary aim was to evaluate anesthesia providers' knowledge of the site equipment capabilities before and after introducing the total power failure protocol.

Literature Review

The true incidence of electrical power failure in the operating room is difficult to quantify because there is no standard reporting system. A search of PubMed and Embase (Elsevier) identified 13 published case reports of partial or complete power failure in American, UK, Australian, and New Zealand hospitals occurring between 1993 and 2014. All available cases of hospital power failure were pub-

lished voluntarily, which could indicate there are many other occurrences that have gone unreported.

Loss of operating room electrical power may be caused by severe weather, regional blackouts, or building electrical faults.^{1-10,13,14} The incidence and severity of primary electrical grid failures caused by severe weather events in the United States are predicted to increase in the coming years.¹⁵ Electrical power failure is a very real and serious threat to the safety of an anesthetized patient because of the limited life of backup batteries in electrically powered anesthesia patient care equipment, or in some cases complete lack of backup battery power.^{11,12}

The user reference manual for anesthesia patient care equipment should include reliable information on backup battery life and equipment capabilities while operating on battery power. Unfortunately, user reference manuals for some AGMs are nonspecific regarding battery-powered capabilities. Datex-Ohmeda's (now part of GE Healthcare Systems) user reference manuals for the Aisys CS² and Avance S/5 AGM claim they can operate on battery power for 90 minutes under "typical" operating conditions or 30 minutes under "extreme" conditions.^{16,17} Neither manual defines what is meant by typical or extreme conditions, which could cause great uncertainty among anesthesia providers during a power failure.

Datex-Ohmeda AGM Aisys CS² and Avance user reference manuals do provide some critical pieces of information regarding machine performance while on battery power. For example, both machines will maintain gas flow, inhaled anesthetic agent setting, and ventilation settings during and after a transition to battery power.^{16,17} However, electrical outlets on the back of the machine (if equipped) are not powered by the battery.^{16,17} Any device plugged in to the back of the machine must have its own battery power if it is expected to function during a power failure.

Anesthesia providers are faced with multiple competing demands when providing anesthesia, making it easy to take a steady supply of electricity for granted.¹² To optimize patient safety during an operating room power failure, anesthesia providers should prepare as they would prepare for any other crisis by being aware of their equipment capabilities and limitations, and by having an appropriate plan.¹¹ Checklists and cognitive aids have reduced patient morbidity and mortality resulting from rare but serious events in the operating room.¹⁸ A power failure protocol that includes reliable and validated information regarding anesthesia equipment capabilities while operating on battery power could enhance patient care and safety in the event of total power failure.¹¹

Methods

• **Equipment Testing.** Specific anesthesia patient care equipment was tested while operating solely on battery power to better understand its capabilities in the event

of a total power failure in the operating suite. The project implementation site was a large, university-based medical center in the Southeastern United States. The devices evaluated were the Datex-Ohmeda Aisys CS² and Avance S/5 AGMs (GE Healthcare); the B650, B850, Dash 3000, and Transport Pro patient vital sign monitors (GE Healthcare); the Alaris PC intravenous fluid infusion pump (BD); and Omnicell medication dispensing cabinets (Omnicell). The B650 and B850 monitors are integral parts of the AGMs at the testing site, and the Dash 3000 and Transport Pro are portable monitors.

The equipment was evaluated for duration of operation while on battery power and for any loss of functional capability. All devices were plugged in to an electrical outlet overnight and fully charged before being tested. The AGMs were tested with the ventilator both on and off to assess for differences in battery life in each mode. Ventilator settings included volume control ventilation of 500 mL, respiratory rate of 10/min, and oxygen flow of 2 L/min. In the ventilator-on test mode an adult anesthesia breathing bag was attached to the circuit. All vital sign monitors were tested while recording the lead author's (A.G.V.) blood pressure, electrocardiogram, heart rate, pulse oximetry, and temperature. The blood pressure cuff was cycled every 2.5 minutes during the initial tests and then the test was repeated with the blood pressure cuff turned off. The Alaris PC intravenous infusion pumps were tested with 2 fluid channels attached. Channel A was a propofol infusion set to 150 µg/kg/min, and channel B was a syringe pump delivering a phenylephrine infusion at 0.3 µg/kg/min. Both channels were set to deliver the infusion based on a patient weight of 80 kg. All equipment tests were initiated by unplugging the devices from the main power supply to simulate a total power failure. Duration of equipment operation while on battery power was recorded by documenting the time at which the equipment was unplugged, and the time at which the equipment ceased to operate because of battery failure using a digital wristwatch. Loss of equipment capability was determined by evaluating what functions were no longer supported on battery power.

Gases supplied by the hospital's central pipeline system to the operating rooms and the vacuum system used to power suction devices and waste anesthesia gas disposal (WAGD) systems can also be affected by electrical power failure. Because these systems provide gases and vacuum to the entire operating room suite, it was not possible to shut them down to evaluate the effect of a total power failure on their function. However, information regarding how the pipeline gas supply and vacuum systems would behave during an electrical power failure was obtained from our institution's medical repair department. The anesthesia equipment tested and the test parameters are listed in the Table.

• **Protocol Considerations.** Data from the equipment

Device	Make or manufacturer	Model	Mode	No. of devices tested	Average time to failure
AGM	Datex-Ohmeda (GE Health)	Aisys CS ²	Vent on	2	3 h, 47 min
			Vent off	1	3 h, 57 min
AGM	Datex-Ohmeda (GE Health)	Avance S/5	Vent on	2	1 h, 17 min
			Vent off	2	1 h, 19 min
Vital sign monitor	GE Health	B850	BP cuff on	2	Immediate
			BP cuff off	0 ^b	—
Vital sign monitor	GE Health	B650	BP cuff on	2	Immediate
			BP cuff off	0 ^b	—
Portable monitor	GE Health	Dash 3000	BP cuff on	2	2 h, 47 min
			BP cuff off	2	2 h, 37 min
Portable monitor	GE Health	Transport Pro	BP cuff on	1	2 h, 52 min
			BP cuff off	0 ^c	—
IV infusion pump	BD Alaris	PC	2 channels	2	4 h, 37 min

Table. Anesthesia Equipment Test Results^a

Abbreviations: AGM, anesthesia gas machine; BP, blood pressure; IV, intravenous.

^aOmniceil medication dispensing cabinets could be accessed for approximately 10 to 11 minutes on backup battery power.

^bTesting was not repeated with the blood pressure cuff off because there was no backup battery.

^cTesting was not repeated with the blood pressure cuff off because the Transport Pro uses the same interchangeable battery used in the Dash 3000. Monitor life appears to depend more on battery condition than model.

testing, information regarding the hospital's pipeline gas supply and vacuum systems, and the function of the medication carts was synthesized and condensed into the Operating Room Total Power Failure Protocol. The protocol steps were based on several key considerations that arose throughout the equipment testing process. Datex-Ohmeda AGMs will continue to ventilate a patient using the existing settings after transitioning to backup battery power. However, ventilation settings and oxygen pipeline pressure should be confirmed before moving on to other priorities because a severe weather event or building fire could damage the oxygen supply system. Loss of the pipeline oxygen supply could result in failure to ventilate the patient because Datex-Ohmeda AGMs use oxygen to drive the ventilator bellows.^{16,17} The B650 and B850 patient vital sign monitors associated with the AGMs at the project site do not have backup battery power and therefore will not function during an electrical power failure. Battery-powered Dash 3000 and Transport Pro portable patient vital sign monitors are available at the site, as well as manually operated equipment such as sphygmomanometers.

Although the central pipeline supply of oxygen and nitrous oxide remains available during a total power failure, the medical air supply does not because it relies on an electrically driven compressor. The WAGD system is also unavailable because it is powered by a vacuum pump, which fails without electrical power. The effects of a total electrical power failure on the availability of the electronic medical record (EMR) could not be directly tested because it is in continuous global use throughout the medical center; however, failure of the B650 and B850

monitors would prevent patient vital signs from flowing through to the EMR even if it remained functional. The Omnicell medication cabinets can be accessed for approximately 10 to 11 minutes on backup battery power. Following this brief period, nonscheduled drugs can be accessed by breaking a seal on the cabinet; however, scheduled drugs are no longer accessible and at this point must be obtained directly from the pharmacy department.

• **Practitioner Education and Evaluation.** An education session was held at a staff meeting of nurse anesthetists to introduce and explain the power failure protocol before distribution in the operating rooms. The education session focused on the causes and effects of power failures in the operating room, capabilities of the site anesthesia equipment while operating on battery power, pipeline gas supply and vacuum availability during a power failure, effects of a power failure on the medication dispensing cabinets, and how to reliably document patient care during a power failure.

Potential improvement in provider knowledge regarding power failure in the operating room and the capabilities of the site anesthesia equipment were measured using a pretest-posttest. Because we could find no validated tool in the literature to assess knowledge of anesthesia equipment capabilities during a total power failure, we generated a brief list of questions and circulated it to 2 anesthesia Doctorate of Nursing Practice program faculty members, who agreed on the questions' face validity. The pretest and posttest were administered before and immediately after the education session and contained the same 10 multiple-choice questions (Figure 1). Anonymity was maintained by not requiring practitio-

Pre and Post Test
Power failure in the operating room

To answer the following questions, assume there has been a total power failure with no backup generator activation at your hospital. You are providing general anesthesia and approximately halfway through a surgical case when the power fails.

1. Pipeline gases that remain available during a total power failure include _____.

- A. Medical air
- B. Nitrous oxide
- C. Oxygen
- D. B & C
- E. All of the above

2. A monitor attached to an anesthesia gas machine shows this battery indicator on the screen. It can be expected to operate for approximately how many minutes on battery power only?

- A. 90 minutes
- B. 60 minutes
- C. 30 minutes
- D. 0 minutes



3. Aisys anesthesia gas machines can be expected to operate for approximately how many hours on battery power only?

- A. 3-4 hours
- B. 2-3 hours
- C. 1-1.5 hours
- D. 0.5-1 hour
- E. Less than 0.5 hour

4. Avance anesthesia gas machines can be expected to operate for approximately how many hours on battery power only?

- A. 3-4 hours
- B. 2-3 hours
- C. 1-1.5 hours
- D. 0.5-1 hour
- E. Less than 0.5 hour

5. The battery indicator on an Aisys or Avance anesthesia gas machine has turned from green to yellow. How much battery time remains?

- A. 45 - 60 minutes
- B. 30 - 45 minutes
- C. 15 - 30 minutes
- D. < 10 minutes



6. Which component of the Aisys and Avance anesthesia gas machines is NOT powered by the battery?

- A. Ventilator
- B. Oxygen sensor
- C. Outlets on the back of the machine
- D. End tidal CO2 monitor
- E. Electronic gas mixer

7. Transport monitors (Dash 3000 or Transport Pro) with fully charged batteries can be expected to operate for approximately how many hours on battery power only?

- A. 3.5-4 hours
- B. 3-3.5 hours
- C. 2.5-3 hours
- D. 2-2.5 hours
- E. 1-2 hours

8. Suction and waste anesthesia gas disposal (WAGD) systems experience what during a power failure?

- A. Complete failure
- B. Suction fails, but WAGD continues
- C. Suction continues, but WAGD fails
- D. Both suction and WAGD continue

9. How do power failures affect access to drugs in the Omnicell?

- A. Omnicell locks, preventing access to any medications
- B. Omnicell locks, but access may be obtained via the red emergency drawer release
- C. Omnicell transitions to battery power, allowing about 10 minutes of access before locking. Access may still be obtained via the red emergency drawer release.
- D. Omnicell automatically unlocks without electrical power.

10. Operating room power failures have been caused by which of the following?

- A. Severe weather
- B. Fires
- C. Electrical malfunctions
- D. All of the above

Answer Key: 1-D, 2-D, 3-A, 4-C, 5-D, 6-C, 7-C, 8-A, 9-C, 10-D

Figure 1. Test to Evaluate CRNA Knowledge About Equipment Capabilities and Duration of Operation After Total Power Failure^a

Abbreviation: CO₂, carbon dioxide.

^aOmicell is a brand of medication dispensing cabinet.

ner names on the test; however, the pretest and posttest were matched by a number system that allowed for comparison before and after the education session.

Results

• **Equipment Testing.** Onsite testing of the AGMs' battery life revealed substantial differences from the manufacturer's battery life claims from the user reference manuals (90 minutes under typical operating conditions; 30 minutes under extreme conditions). The Aisys CS² machine's average time to failure with the ventilator on was 3 hours and 47 minutes. The Avance S/5 machine's average time to failure with the ventilator on was 1 hour and 17 minutes. Both machines continued to function as programmed until complete battery failure. The AGMs were subsequently retested with their ventilators off to determine whether or not duration of operation would increase. The Aisys CS² machine functioned for 3 hours and 57 minutes, and the Avance S/5 functioned for 1 hour and 19 minutes. There was no clinically relevant difference in time of operation with and without the ventilator operating for either of the AGMs while on battery power.

The B650 and B850 patient vital sign monitors at the project site are not equipped with backup batteries and,

therefore as expected, failed immediately after being unplugged from their electrical outlet. The Dash 3000 and Transport Pro portable patient vital sign monitors functioned for 2 hours and 47 minutes and 2 hours and 52 minutes, respectively, on battery power with the blood pressure cuff cycling every 2.5 minutes.

The Alaris PC intravenous infusion pump has a digital on-screen battery life indicator feature that estimates and displays the remaining operating time while on battery power. Both pumps tested displayed an estimated battery life of 4 hours and 30 minutes when unplugged from an outlet. Their actual average operating time on battery power was 4 hours and 37 minutes. The Table summarizes the average times to equipment failure on battery power.

• **Protocol Generation and Distribution.** The final protocol for total power failure was generated based on the equipment tests and review of the data and input from anesthesia staff at the project site. The primary protocol contained 7 fundamental steps to take in the event of a power failure and was printed, laminated, and attached to AGMs in the main operating room suite for reference in the event of a total power failure. The primary protocol instructs the anesthesia provider to evaluate AGM function and anticipate failure of suction, WAGD, EMR,

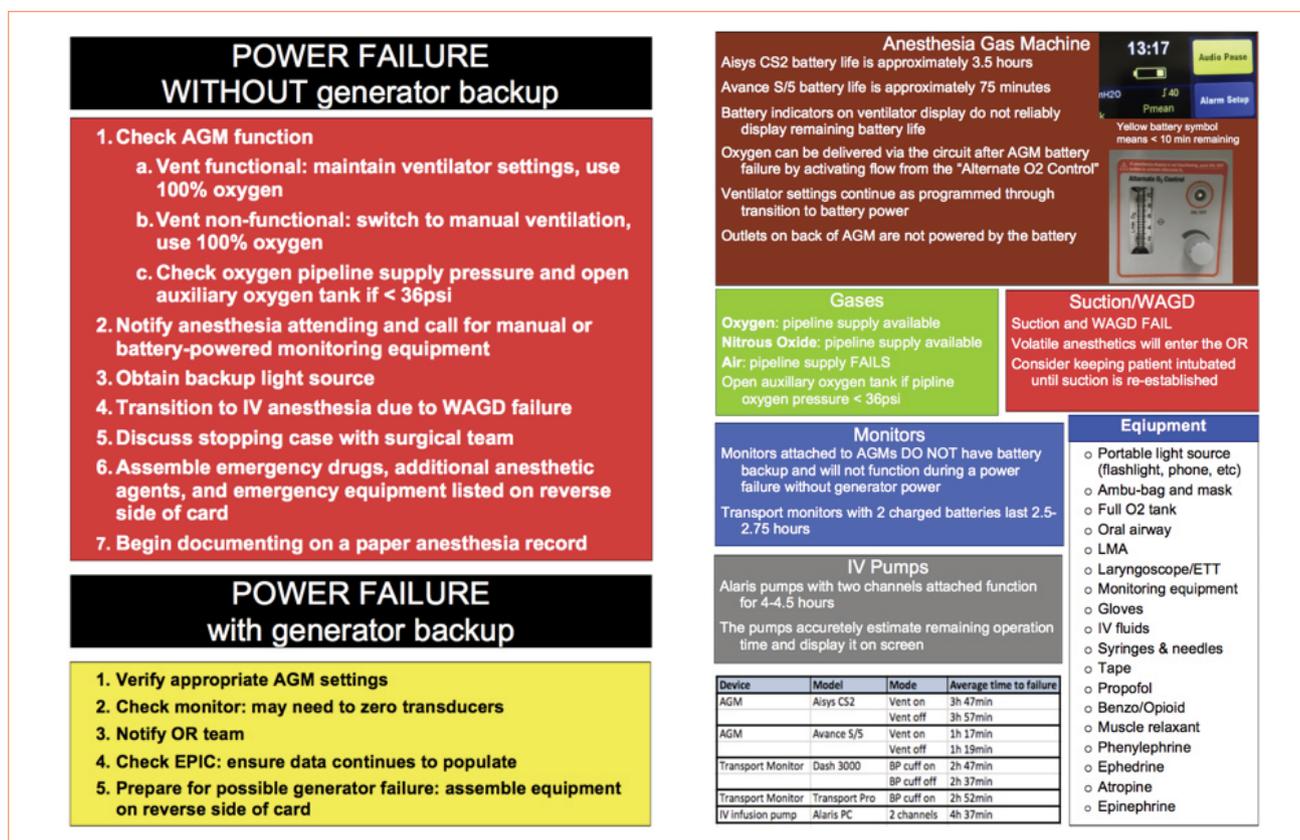


Figure 2. Final Protocol for Operating Room Power Failure With and Without Generator Backup^a
Abbreviations: AGM, anesthesia gas machine; Ambu bag, brand of bag-valve-mask resuscitator (Ambu); benzo, benzodiazepine; BP, blood pressure; Epic, brand of electronic medical record (Epic Systems Corp); ETT, endotracheal tube; IV, intravenous; LMA, laryngeal mask airway; O₂, oxygen; OR, operating room; WAGD, waste anesthesia gas disposal.
^aPage 2 (reverse side of card) contains expanded information with regard to equipment capabilities, battery life, and equipment considerations for maintaining and transporting the patient during a total power failure.

and medication cabinets. Other important considerations for patient care during an electrical power failure were addressed by the protocol as well. The battery life was noted for the AGM, portable vital sign monitor, and intravenous fluid pump so that anesthesia providers would know what to expect from their equipment if a transition to battery power occurred. Information about the pipeline gas supply was provided to avoid premature transition to reserve tank supplies. Finally, an emergency equipment checklist was provided to help anesthesia providers assemble all the drugs and equipment they may need to care for their patient until the patient can be transferred or until power is restored (Figure 2).

• **Practitioner Evaluation.** A total of 42 nurse anesthetists attended the education session. Of those, 28 completed the pretest and posttest, and their data were therefore used for the pretest to posttest comparison. Test scores were evaluated with a Wilcoxon signed rank test. A significant improvement was noted in the median test score between the pretest and posttest ($P < .001$). The median score on the pretest was 30%, which increased to 88% on the posttest. All posttest questions demonstrated

an increase in the percentage of correct responses with the exception of question 10, which had a 100% correct response rate on both the pretest and posttest (Figure 3).

Discussion

Although loss of the main power supply to the operating room and failure of the backup generator system is a rare and unlikely occurrence, anesthesia providers should prepare for it as they would for any other critical event that could have an impact on patient safety. It is impossible to measure with any statistical certainty the patient care impact of implementing a total power failure protocol because of the rarity of its occurrence, but the wisdom of knowing one's equipment capabilities and duration of operation on a backup battery is reasonably intuitive.

Comparing actual battery life of the 2 AGMs tested to the battery life provided by their respective user reference manual revealed clinically important differences. Avance S/5 machine users would be unlikely to reach the 90-minute mark noted in the user reference manual and could overestimate their machine's capability in the absence of actual test data. Aisys CS² users could grossly

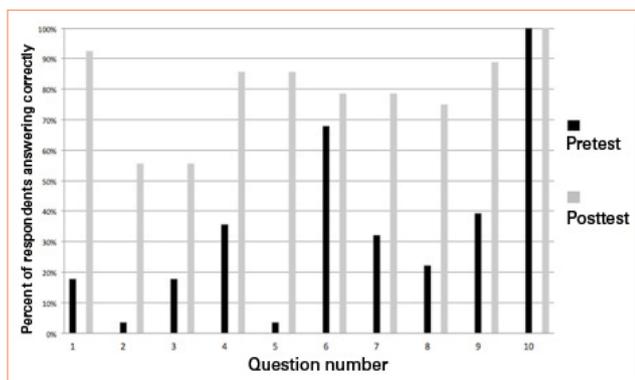


Figure 3. Comparison of Nurse Anesthetists' Pretest and Posttest Knowledge of Equipment Capabilities and Duration of Function After Total Power Failure

underestimate their machine's capability if they assumed the backup battery would last for only 90 minutes. The large difference in battery life between the Avance S/5 and Aisys CS² AGMs could significantly affect how an anesthesia provider decides to manage a patient's care. Knowledge of how much time is available before battery failure could prevent a premature transition to ventilation with a self-inflating bag and could also be helpful in facilitating an intraoperative team discussion on how to proceed with a surgical case in the event of a total power failure. Attempting to complete the procedure may be inappropriate or impossible during an electrical power failure because of the concomitant failure of anesthesia and surgical equipment. The surgical and anesthesia teams must agree on the safest course of action under the circumstances and arrange for a safe place for the patient to receive care until electrical power is reestablished.

Lack of battery backup power in our facility's B650 and B850 monitors associated with the AGMs is certainly an unfavorable characteristic in the event of a total power failure. However, being aware of this limitation could prompt the anesthesia provider to rapidly procure a battery-powered backup monitor if a total electrical power failure was imminent. The availability of a battery-powered vital sign monitor does not solve the documentation problem created by having the B650 and B850 monitors "slaved" to the EMR system. In our setting this circumstance requires generation of a paper anesthesia record.

The Alaris PC infusion pump's digital on-screen battery life indicator was unique among the equipment tested and demonstrated an excellent degree of precision compared with our manual timing test data. In contrast, the AGMs indicated remaining battery life by an on-screen icon of a gradually depleting battery—a method common to household electronic items. Depletion of the battery icon to any given level, however, is of little value because (1) the provider would not know how much battery operating time was available at the time of the power failure and (2) a bar on the battery icon suggesting

to the viewer that 50% of the original battery is available may result in only a few minutes of remaining operating time based on our testing. It seems counterintuitive that a simple infusion pump would provide a better indicator of battery life than a sophisticated, life-sustaining, and much more costly AGM.

Some caution should be taken with respect to the measurement of battery life of any piece of equipment because battery life is dependent on the age of the battery and number of times it has been recharged. In our institution, AGM backup batteries are replaced every 2 years, and this is tracked via a computer-based schedule maintained by our medical equipment department. However, there is no such tracking or scheduled battery replacement for other equipment.

Knowing that the pipeline supply of oxygen remains functional during a total power failure could prevent a premature transition from pipeline supply to the AGM reserve oxygen tank, and the reserve oxygen supply could be maintained for a longer time. Similarly, being aware that the hospital's vacuum system that provides negative air pressure to the suction and WAGD system is unavailable may influence patient airway management decisions. There is not only loss of patient suction capability but also possible operating room contamination with anesthetic gas if inhalation anesthesia is being used during a power failure. Transitioning from inhaled to intravenous anesthetic agents would minimize contamination and protect operating room personnel from exposure to inhaled anesthetic gases.

Important objectives of this project were to create a locally relevant, available, and easily manageable protocol in the event of a total power failure and to disseminate it to departmental anesthesia providers and evaluate its educational impact. Nurse anesthetists who participated in the educational session, were exposed to the power failure protocol, and took the pretest and posttest demonstrated an improved understanding of their equipment capabilities and limitations during an electrical power failure. Whereas the best measurement of the protocol's effectiveness would be to measure the actual anesthesia provider response during a total electrical power failure, the spontaneous and infrequent nature of power failures made that impossible. At a minimum, the providers now know where to find the information they will need to provide the best possible care for their patient if a total electrical power failure were to occur. Future research in this area could evaluate anesthesia provider responses to a power failure in a simulation environment.

Conclusion

Although the ideal condition would be to never experience a total power failure in the operating room, preparation for such an event is critical. Rapid and rational decision making based on validated information may be

lifesaving during a total power failure because many of the devices and systems relied on in the operating room cease to work or have reduced functional capacity without electricity. The potential for electrical power failure is easily overlooked because of the high reliability of the electrical power supply and the presence of backup generators, but the consequences can have important ramifications on patient management in the operating room. A site-specific protocol for operating room power failure could greatly improve anesthesia provider decision making in the event of a total power failure. Anesthesia providers at our institution now have a useful and immediately available resource to help them understand which components of their patient care equipment can be relied on and how long they will function. Because the anesthesia equipment and conditions under which the equipment is used to deliver care differ from site to site and within various locations at specific sites, anesthesia providers should independently verify device functionality at each site and location when developing a total power failure protocol.

REFERENCES

1. James E. A case of complete power failure [abstract]. *Anaesthesia*. 2014;69(suppl 3):38.
2. Mathias JM. Surgery by flashlight as Joplin team operates through tornado. *OR Manager*. 2011;27(7):1, 6-7.
3. Mitchell J. Complete power failure 1. *Anaesthesia*. 2001;56(3):274. doi:10.1046/j.1365-2044.2001.01918-3.x
4. Norcross ED, Elliott BM, Adams DB, Crawford FA. Impact of a major hurricane on surgical services in a university hospital. *Am Surg*. 1993;59(1):28-33.
5. O'Hara JF Jr, Higgins TL. Total electrical power failure in a cardiothoracic intensive care unit. *Crit Care Med*. 1992;20(6):840-845.
6. Pagan A, Curtly R, Rodriguez MI, Pryor F. Emergency—total power outage in the OR. *AORN J*. 2001;74(4):514-516. doi:10.1016/S0001-2092(06)61684-0
7. Riley RH. Power failure to a tertiary hospital's operating suite. *Anaesth Intensive Care*. 2010;38(4):785.
8. Troianos CA. Complete electrical failure during cardiopulmonary bypass. *Anesthesiology*. 1995;82(1):298-302.
9. Tye JC, Chamley D. Complete power failure. *Anaesthesia*. 2000;55(11):1133-1134.

10. Yasny J, Soffer R. A case of a power failure in the operating room. *Anesth Prog*. 2005;52(2):65-69. doi:10.2344/0003-3006(2005)52[65:ACOAPF]2.0.CO;2
11. Holland EL, Hoaglan CD, Carlstead MA, Beecher RP, Porteous GH. How do I prepare for OR power failure? *APSF Newslett*. 2016;30(3):57-62.
12. Eichhorn JH, Hessel EA 2nd. Electrical power failure in the operating room: a neglected topic in anesthesia safety. *Anesth Analg*. 2010;110(6):1519-1521. doi:10.1213/ANE.0b013e3181dce129
13. Mathias JM. Blackout, Isabel offer lessons in preparing for emergencies. *OR Manager*. 2003;19(11):1, 7-8.
14. Carpenter T, Robinson ST. Case reports: response to a partial power failure in the operating room. *Anesth Analg*. 2010;110(6):1644-1646. doi:10.1213/ANE.0b013e3181c84c94
15. Larsen PH, LaCommare KH, Eto JH, Sweeney JL. *Assessing Changes in the Reliability of the U.S. Electric Power System*. Berkeley, CA: Lawrence Berkeley National Laboratory; 2015.
16. Datex-Ohmeda Inc. *Aisys CS² User's Reference Manual*. Software Revision 10.X ed. Chicago, IL: GE Healthcare Systems.
17. Datex-Ohmeda Inc. *Avance User's Reference Manual*. Software Revision 6.X ed. Chicago, IL: GE Healthcare Systems.
18. Haynes AB, Weiser TG, Berry WR, et al; Safe Surgery Saves Lives Study Group. A surgical safety checklist to reduce morbidity and mortality in a global population. *N Engl J Med*. 2009;360(5):491-499. doi:10.1056/NEJMsa0810119

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DISCLOSURES

The authors have declared no financial relationships with any commercial entity related to the content of this article. The authors did not discuss off-label use within the article. Disclosure statements are available for viewing upon request.