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Patient Safety Tip of the Week

September 15, 2020

An Eerily Familiar Incident

In our April 2, 2007 Patient Safety Tip of the Week "More Alarm Issues" we described a catastrophic case with numerous lessons learned. A patient with asthma arrived mid-morning at an emergency room with status asthmaticus. Treatment was begun but the patient required intubation and mechanical ventilation. He was stabilized and the ICU was called to admit the patient. The ICU had no empty beds but told the ER that they expected a bed to open up shortly. The ER said the patient could stay on a ventilator in an ER room until that bed was ready. Respiratory Therapy evaluated the patient and hooked the patient up to a dual power-source portable ventilator. That was felt to be ideal for this patient because it could be used either with typical AC current in the ER or use its built-in battery during transport.

A call to the ICU after an hour still found no available ICU bed. The ER now started getting busier, but the patient remained stable on the portable ventilator. Unbeknownst to all, the circuit breaker on the AC wall source had tripped, so the portable ventilator was running on battery power. After 5 hours in the ER, the portable ventilator exhausted its battery power and ceased functioning. The patient had a respiratory and then cardiac arrest.

Investigation revealed that no staff had heard any alarms on the EKG monitor even though it was likely the patient would have developed tachycardia and/or bradycardia after the ventilator had ceased functioning. The alarm volume, in fact, had been turned down to a level barely audible even by those in the immediate room. The room was immediately adjacent to the nursing and secretarial work area and staff had turned down the alarm volume because it distracted them from work.

When the hospital team conducting the RCA investigation came to the ER to re-enact the events, they found that the volume on the same alarms had been turned down again. A similar visit done with the health department a week later again found the alarm volume turned down.

Avoiding the snap reaction to take punitive action against the staff member who had initially turned down the alarm volume, it became very clear that the root cause was a flawed design to the ER plus a serious problem with the "culture" in the ER. That design

of the ER led to the practice of turning down the alarm volume. One wonders how many ER's, ICU's, etc. suffer from this same type of design flaw that promotes such an unsafe practice. I'm always amazed when a hospital administrator proudly states "we designed this unit to have full visual contact of all patients", only to find that the very proximity led to this practice of lowering alarm volumes. A second root cause was the development of a "culture" in the ER that tolerated manipulation of the alarms as an unsafe workaround.

Another root cause was in the design of the portable ventilator. How was one to know that it was functioning on battery power rather than AC power from the wall outlet? In fact, it did have an indicator light to flag which power source was being utilized. However, that indicator light was located on the back of the unit and not readily visible to staff in the room.

The case is also a good example of how technological "safety" advances may not actually reduce accidents, much like maritime radar simply encouraged ships to go faster. In this case, the "ideal" dual power-source ventilator fostered a false sense of security.

Lastly, the bottleneck caused by bed unavailability in the ICU was yet another root cause that led to implementation of a better system for triage of ICU beds.

A very unfortunate case but it illustrates multiple points that one often sees in cases with adverse outcomes (cascade of errors, latent errors, violations, unsafe workarounds, communication breakdowns, misuse of alarm systems, multiple design flaws, safety "culture" issues, bottlenecks and patient flow issues, and technological advances with unintended consequences).

Fast forward to 2020. A recent Anesthesia Patient Safety Foundation (APSF) case report (Levin 2020) sounds eerily similar to that incident. During the COVID-19 crisis, a patient with respiratory failure was housed in a windowless negative pressure room in a telemetry unit that had been converted to a temporary COVID-19 ICU. Because of the concomitant ventilator shortage, an anesthesia machine ventilator was used to ventilate the patient. On the tenth hospital day an audible alarm sounded at the central station and the patient's SpO2 was noted to be 45%. Staff responding to the alarm found that multiple things controlled by electricity in the room were not working. The anesthesia ventilator itself was not working and its workstation control screen was dark. The AC power indicator light was off. However, the physiologic monitor, which had a separate battery backup system, was on and functioning. The patient was removed from that ventilator and manually bagged, with prompt return to baseline oxygen saturation levels.

The anesthesia machine ventilator was then connected into a different electrical outlet. The AC power indicator light came on and the machine rebooted. Staff performed the usual pre-use checks and reconnected the patient to the ventilator.

Investigation confirmed that the power supply to the anesthesia machine had been lost due to a tripped circuit breaker, just as in our earlier case. Review of the service log

revealed an AC power loss and appropriate cutover to the backup battery. Several alarm messages had been displayed on the workstation screen beginning 28 minutes after the AC power loss progressing from “Battery Low”, “Battery V Low” to “Battery V VERY LOW” and, after 1 hour 43 minutes, to “Battery Empty.” The system shut down after 1 hour 52 minutes. Thus, the anesthesia machine had functioned fully as it was designed to work. It was also likely that use of several electrical appliances in the room may have led to the circuit breaker tripping.

During normal use of an anesthesia workstation, “a qualified anesthesia provider is in constant attendance, able to view the screens, hear audible alarms, and make adjustments as necessary”. The APSF/ASA Guidance on use of such workstations as ventilators elsewhere includes the recommendation that “An anesthesia professional needs to be immediately available for consultation, and to ‘round’ on these anesthesia machines at least every hour.”

Fortunately, the patient in the Levin case did not suffer the dire consequences seen in our earlier case. But the similarities between the two cases are striking. In each case, the tripping of the circuit breaker went unnoticed and staff were unaware that the ventilator was running on battery backup power. While each device did have an indicator that it was on battery backup power, that indicator was either in a position not readily visible or the screen with the warning was not observed because no one was in the room. Multiple root causes were involved in both cases. Unforeseen circumstances led to the use of the surrogate ventilator in both cases (the COVID-19 pandemic in the Levin case, and the ICU backup on our first case). Staff unfamiliarity with the devices may have played a role in each case. Poor design of the working area contributed in both.

The Levin study notes that many conventional ventilators used in ICU’s today also have battery backup systems, some of which only last an hour and that the same problem could have occurred with a conventional ventilator. They also note that some of those ventilators lack the remote monitoring capability that was critical in alerting staff in the current case.

Our recommendations from lessons learned in these 2 cases:

- Be aware that any time you use equipment that is unfamiliar to staff, errors will be more likely. Extra vigilance is required.
- Similarly, makeshift environments that are unfamiliar to staff may also be more prone to unexpected events.
- All equipment that has a “backup” (battery) electrical system should have a readily visible tag that states “This system has a battery backup that is expected to last ___.” “It was last checked on _____ and battery capacity was at ___%. You need to be aware that the primary electrical source could be interrupted without your awareness.” It should also indicate how you would be notified if the unit switched to battery backup power.
- Battery capacity should be checked immediately before the equipment is deployed to patient use.

- There must be a way in which the staff become aware that the unit is on battery backup power (that must include audible as well as visual alerts).
- The machine then must be deployed in a manner that they will be alerted when the battery runs out.
- Do an inventory to see which of your devices have battery backups.
- You need a system for regular battery checks on all equipment that runs on batteries (our February 4, 2014 Patient Safety Tip of the Week "But What If the Battery Runs Low?").
- Don't purchase a machine that lacks a readily visible way to alert staff the machine is on battery power (don't put the indicator light on the back of the machine!!!).
- For equipment like ventilators, don't use an outlet that is also being used by multiple other devices.
- Whenever possible, put your monitoring devices/alarms on an outlet separate from the one the ventilator is on.

Our bet is that these are not the only cases out there where failure to recognize equipment is running on battery backup led to disasters or near misses. The potential contributing factors are likely present in many hospitals.

References:

Levin MA, Burnett G, Villar J, et al. Anesthesia Machine as an ICU Ventilator-A Near Miss. APSF (Anesthesia Patient Safety Foundation) 2020; September 4, 2020 https://www.apsf.org/article/anesthesia-machine-as-an-icu-ventilator-a-near-miss/

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