Flying blind in anesthesia: A safety concern

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ABSTRACT
We describe two cases of sudden loss of display of all the monitors of Zeus anesthesia workstation during operation, which is a major safety concern. Flying blind in anesthesia could be devastating. These cases attempt to highlight the need for greater vigilance by anesthesiologists and have implications for improvement in technology.

Key words: Anesthesia workstation dysfunction, monitor shutdown, sudden shutdown anesthesia machine

INTRODUCTION
The term equipment malfunction refers to failure to serve its purpose due to faulty design, wear and tear or defective service.[1] Safety is a major goal in anesthesiology and machine malfunction may contribute to morbidity and mortality.[2] Monitoring plays a pivotal role in safe delivery of anesthetics and identifying avoidable catastrophic events. Approximately 40% of the critical incidents are due to monitors’ failure.[3] We report two incidents of intraoperative failure of all the monitors of Zeus anesthesia workstation (ZAWS) Drager® Germany. As a safety issue, this report will alert the anesthetist community and the manufacturers of ZAWS for further improvement in strategies and technology.

CASE REPORTS
Case 1
The first case is about a 2-year-old baby who was operated for lower abdominal urological surgery under general anesthesia and caudal block. After induction of anesthesia and endotracheal intubation, the patient was kept on controlled ventilation on ZAWS. Standard non-invasive monitoring was used. Biegler® fluid warmer was attached to auxiliary power supply outlet (APSO) of the ZAWS. After about 1 h of start of surgery, we noted a warning on the screen “Failure of the user control, system continues to operate and system will restart in 76 s” [Figure 1]. Following that warning the monitoring screen turned blank. However, within a minute or so, all the parameters were displayed as before. Few minutes later, the same warning reappeared along with the same sequence of events which was followed by normal screen and proper display. About 4 min later, another warning was displayed “System will be re-started and lasts approximately 3-min.” and ZAWS started booting [Figure 2]. During that period the anesthesia workstation (AWS) was not displaying any parameters at all. Interestingly during these events the ventilator kept on working. We administered midazolam intravenously and arranged a portable pulse oximeter, which showed SPO2 of 99%. After about 3 min and passing through various steps (up to step 5) of starting process [Figure 3], the ZAWS restarted in safety settings (which were the same as we set before the incident). The operation continued for about 90 min after that incident and we used the same ZAWS for the rest of the surgery. At the end of the procedure the anesthetics were terminated and the patient recovered uneventfully without any sequel.

Case 2
The second case is about a 32-year-old patient who was operated for decompression and fixation of cervical spine...
The patient received general anesthesia using ZAWS and his ventilation was controlled. Intraoperative monitoring was standard non-invasive along with invasive blood pressure. None of the equipment was attached to APSO of the ZAWS. After about 120 min into the operation, ZAWS monitors started flickering which was followed by complete shutdown of monitors without any warning sign. Remarkably, the ventilator continued to work even after the monitors’ shutdown. Surgical procedure was stopped and Ambu bag was kept ready for control of ventilation in case the ZAWS ventilator failed (as a rescue measure). Additional dose of midazolam and fentanyl were administered in order to avoid any awareness during the incident. Portable pulse oximeter was arranged. It took about 15 min to replace the ZAWS by our biomedical engineering department. At the end of surgery patient was recovered and fortunately, even after such serious incident the patient incurred no harm.

**DISCUSSION**

This case report is unique in that we experienced two similar events of intraoperative failure of ZAWS monitors. Both events occurred in two different operating rooms, with different ZAWS and two different anesthesia teams. During recent past, anesthesia machines have improved tremendously. ZAWS are one of the most advanced forms of anesthesia machines available. Despite of all the advancement and incorporated safety features, failure of such machine can still happen. To avoid any mishap, AWS, anesthetist and system should be geared enough to deal with any such situation. All modern AWS perform their own self checking. The person responsible for checking the AWS only has to follow the instructions displayed on the screen. We encountered failure of monitors intra-operatively in both the cases. Both the ZAWS had passed the self-test on the day of the incident. In one case the monitors’ display resumed within a few minutes (after restart process) but in other the monitors failed completely and never recovered.

There is a paucity of literature on such incidents and we could only find one report of sudden non responsiveness of touch screen, black out of ZAWS with ventilator failure, followed by restart of machine. In the report the authors proved that the cause of the incident was electrical interference which was transmitted from the diathermy through the power cord of the electric blanket attached to APSO of the ZAWS. As a solution, the authors suggested to unplug the power socket of the electric blanket attached to ZAWS or to use an optical signal relay to interrupt the passage of electric interference via the USB port of the device computer. In our ZAWS, three APSO are provided with maximum allowance of 4-A current. In case no. 1, only one fluid warmer (1.5 A) was attached to the power outlet. In our opinion, electrical backflow through APSO may not be a cause as long as the equipment attached to APSO is within the manufacturer's granted current limit. Furthermore, during the sudden restart process, usefulness of removing any additional equipment attached to APSO...
of ZAWS is questionable. No additional equipment was attached to these power outlets of ZAWS in our case 2 which rules out any backflow of current, as explained by the previous authors.[9]

To investigate the issue further, we contacted the manufacturer of ZAWS to get an official statement regarding the incidents. According to them, in case no. 1, the cause was failure of a part of ZAWS (Hermes PC) which was subsequently replaced; and the incidence of such malfunctions was within the acceptable range hence they did not deem it necessary to issue any safety customer alert. Moreover, regarding electromagnetic interference a possible cause of the incident, ZAWS manufacturers responded that they strictly comply with international standards (IEC60601-1-1:2001). Conversely, in case no. 2, no fault was found in ZAWS. According to the ZAWS manufacturers, in such situations, the continuation of the ventilation with oxygen is a safety feature, however, anesthetics are terminated. We suggest supplementing with hypnotic and analgesia during such event in order to avoid awareness during anesthesia. To overcome such problems in future, our biomedical engineering department (in consultation with the engineers of the ZAWS) has started a practice of removing unnecessary data from the machine’s memory by routinely using “reset mode” (about twice a week). This practice has eliminated the recurrence of any such incident.

These two incidents highlight certain safety concerns. During the period of black out and restarting of the ZAWS, none of the basic monitoring or ventilatory parameters (ETCO2, tidal volume, respiratory rate, airway pressure and anesthesia gases) was displayed. Although the ventilator was working but adequacy of oxygenation, ventilation and depth of anesthesia could not be assessed. Fortunately both of our patients were not critically ill. We believe that if it had happened in a critically ill patient with inotropes/vasopressors on board, it could have been disastrous. It was a unique experience to lose all the monitors at the same time and can be a nightmare for any modern anesthetist to fly blind. On the basis of our experience, we feel that the incidence of losing all the monitors could not have happened if we were using a conventional anesthesia machine with isolated monitors for different parameters.

We believe that there is always a room for improvement in technology and hence, suggest the manufacturer to dedicate a separate screen for its monitoring system exclusively, where it should continue to display parameters at all times, even during any restart process; this will help avoid such malfunctions in the future.

**CONCLUSION**

Our cases demonstrate that the equipment failure can occur with even the most modern and an advanced machine for whatever reason and highlights the need for improvement in technology in order to avoid such nightmares. All anesthesia departments should develop guidelines in order to deal with these types of situations and we suggest the availability of a spare anesthesia machine (of the same make) in the vicinity of operating rooms. As a pre-emptive measure, we propose all the end users of AWS to perform drills and run similar simulation scenarios in their hospitals and devise a system for replacement of the faulty equipment (if discovered during surgery) in the shortest time interval.

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