Unit-wide Notification of Ventilator Disconnections

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Abstract. The alarms generated by mechanical ventilators when patients become disconnected can blend in with other typical sounds of the intensive care unit. Ventilator alarms that go unnoticed for extended periods of time often result in permanent patient harm or death. We developed a unit-wide system to monitor ventilator disconnection alarms. When a disconnection is identified, the system takes control of every computer in the patient’s intensive care unit and generates an enhanced audio and visual alert. This system was tested in four ICUs at LDS Hospital. Acceptance by medical personnel was very high and patient safety was improved through early intervention that avoided prolonged hypoxia. In addition, the system facilitated root cause analyses and new safety strategies.

Background. While mechanical ventilators are designed to detect disconnections, the alarms are only audible peeps that are often difficult to hear outside of the patient’s room. Thus, some ventilator disconnection alarms go unnoticed for periods of time that result in permanent harm or death. This is a systems problem that is outside of the control of the ventilator and may be due to the physical layout of the ICU, staffing limitations, environmental acoustics and noise or the patient being in isolation. Moreover, information concerning ventilator disconnections was limited and not included in our electronic medical record (EMR). Without this information, process changes to prevent future disconnections or improve patient safety were difficult to identify.

Methods. The ventilators used at LDS Hospital were connected to an external microcomputer that receives current alarm and ventilator settings every five seconds. The microcomputer then sends the ventilator information to the bedside computer. Each bedside computer then transmits this information to a server. If the server receives a disconnection alarm, it identifies all other computers in the same unit and runs a program loaded as a service on those computers. That program then takes control of the computer such that the background of the screen alternates between red and black every three seconds and a message indicates that there is a ventilator disconnection and identifies the room. An audio message containing the “submarine dive horn” is also sent to the non-bedside computers in the unit. The program then logs pertinent information concerning the alert. Once the alarm is corrected on the ventilator, all the computers are restored to the pre-alert status or application. The respiratory therapy-charting program was connected to the system and therapists are prompted to enter specific ventilator disconnection information the next time they chart after the alerted event. That information is loaded into the enterprise data warehouse each night.

Results. The new system was initially tested in the shock/trauma ICU for six months. The new audio/video alerts were very distinct from any other alarms and impossible to ignore. The approval of medical staff was so high that it was requested to be installed in three other ICUs (medical/surgical, coronary care, thoracic). During a four-month pilot study, 152 ventilator disconnections were identified in the four ICUs (2.5 per bed). Forty-two were for unintended disconnections, self-extubations or tube occlusions, all potential life threatening events. Other disconnections were due to ventilator asynchrony or occurred during patient procedures, which can result in patient discomfort and suggest a need for additional education on ventilator adjustment. Average disconnection time from the ventilator was 19.8 seconds. Ventilator disconnection information including the duration time is now stored in the patient’s EMR and log files. Monthly and ad hoc reports now permit respiratory care management to identify each event and perform root cause analyses.

Conclusions. While the prevention of all ventilator disconnections is not possible, this system improves patient safety through early notification of medical staff. We have reduced disconnection times to a level where patient harm does not occur. The system also facilitates root cause analyses and the development of new safety strategies.