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Patient Safety Tip of the Week

November 19, 2024

Oxygen Disruption Events

In one of our very first Patient Safety Tips of the Week (March 5, 2007 "Disabled Alarms") we described a "near-miss" in which a patient's oxygen line had become disconnected from the wall source of oxygen. No alarm went off, but the patient's nurse thought the patient "just didn't look quite right". They had been having trouble with the patient's pulse oximeter. So, the nurse attached a new pulse oximeter, and it confirmed low oxygen saturation. Searching for a reason for the low oxygen saturation, it was discovered that the oxygen line to the ventilator had become disconnected from the wall source of oxygen. So, the patient was basically being ventilated with room air. The line was reconnected to the wall socket and adequate oxygenation rapidly ensured. The patient suffered no harm due to the incident.

However, one of the first questions raised was "why didn't an alarm go off to indicate a low concentration of oxygen coming into the ventilator?" Mechanical ventilators usually have an oxygen blender alarm. This is an alarm that is triggered by oxygen concentration falling below the prescribed level. In this particular case, the alarm failed to alert nursing staff that the oxygen content had dropped.

In the course of the investigation, a piece of tape was found covering the oxygen blender alarm. The alarm, in fact, was functional. It was just not audible because of the tape. We even considered the worst – had someone intentionally disconnected the oxygen line and disabled the blender alarm?

One of the nurses had formerly been a respiratory therapist. She noted that often, during maintenance of the ventilators between use by patients, staff would test the ventilators with compressed air rather than oxygen (as a cost-saving measure). They would tape the blender alarm because it would go off when the compressed air was used instead of oxygen. No other ventilators in use at this hospital were found to have tape over the blender alarm. However, when the potential issue was mentioned in an alert to other hospitals in this multi-hospital system, six other ventilators in actual patient use were found to have tape over the blender alarm!

The protocol used to assess alarms at set-up time for patient use did not include a specific assessment of the blender alarm. The lesson learned in this case is that one should have a checklist-type routine for checking alarms immediately before a ventilator is used on a patient. And the checklist should be specific for the ventilator being used. It is not at all uncommon for a hospital to have multiple different models of ventilators and some may have alarms that others do not. Therefore, your protocol should include not only checking those alarms that are on all ventilators but also those that may be specific to the unit being used. Obviously, those with blender alarms should have a specific item on the check list to confirm the functionality of that alarm.

We never did find out how the oxygen line had become disconnected from the wall outlet (or whether it was never appropriately connected in the first place.). But, it raises the question of how often and why oxygen disconnection events occur. A recent study in the journal Patient Safety (Bocknek 2024) answers some of those questions. Bocknek et al. analyzed 298 patient safety event reports in the Pennsylvania Patient Safety Reporting System to understand the factors contributing to oxygen disruption events.

Almost one quarter of reports involved a patient with high supplemental oxygen requirements (24.8%). The three care area groups where oxygen disruption events occurred most frequently were the Emergency Department (28.9%), Imaging/Diagnostic (17.1%), and Medical/Surgical (12.4%). Over one-third of all reports occurred on the unit where the patient was admitted (36.6%). Approximately one quarter of reports occurred upon the patient's return from off-unit care (22.1%), and one-fifth of reports occurred upon the patient's arrival to off-unit care (17.8%).

They found the most frequent contributing factor to oxygen disruption was the patient not being transferred to another source of oxygen (45.3%), followed by tank found empty (35.9%), patient connected to a functioning oxygen source, no oxygen flowing (8.4%), oxygen delivery device malfunction (7.4%), and no oxygen available (3.0%).

Roughly 40% of reports involved a hand-off breakdown (41.3%) and the most frequent breakdowns occurred between a nurse and a patient transporter (38.2%). Problems maintaining adequate oxygenation are particularly a problem during transport of patients (within or outside of facilities). One statistic you've often heard us quote is that oxygen therapy has been reported to be interrupted in as many as 55% of intrahospital transports (PPSA 2005). Failure modes identified in that study included: failure to treat with oxygen when ordered, failure to initiate flow from the oxygen source, failure to connect the oxygen tubing to the source, failure to place the oxygen delivery device on the patient, and failure to anticipate the oxygen demand and provide an adequate supply throughout the transport. Such interruptions in oxygen delivery were a major reason for development of "Ticket to Ride" checklists for intrahospital transports. Our many columns on intrahospital transports and the "Ticket to Ride" concept are listed below.

Recommendations in the Bocknek study:

- Clarify the responsibilities of the entire care team during hand-offs (e.g., nurses, transporters, procedure technicians, and therapists)
- Conduct oxygen rounds in the ED and imaging
- Evaluate the design of oxygen delivery devices for usability when procuring new products:
- A System-Based Solution: Supervisory Control for Oxygen Tank Monitoring

Interestingly, the Bocknek study found only 7.4% of events classified as "Oxygen delivery device malfunction", which described a break or malfunction involving a device or part of a device that delivers supplemental oxygen (e.g., wall oxygen connector, oxygen tank, connective tubing, or ventilator). They don't have specific recommendations regarding this category. However, we'd repeat our recommendation about having a check list of items to verify when setting up a patient on a ventilator or other oxygen delivery system, including making sure that any monitoring systems (pulse oximetry, oxygen blender alarms) are functioning properly.

Some of our prior columns on intrahospital transports and the "Ticket to Ride" concept:

- April 8, 2008 "Oxygen as a Medication"
- November 18, 2008 "Ticket to Ride: Checklist, Form, or Decision Scorecard?"
- August 11, 2009 "The Radiology Suite…Again!"
- March 13, 2012 "Medical Emergency Team Calls to Radiology"
- August 25, 2015 "Checklist for Intrahospital Transport"
- September 1, 2015 "Smarter Checklists"
- November 2016 "Oxygen Tank Monitoring"
- February 2018 "Oxygen Cylinders Back in the News"
- May 22, 2018 "Hazardous Intrahospital Transport"
- October 30, 2018 "Interhospital Transfers"
- March 31, 2020 "Intrahospital Transport Issues in Children"
- June 23, 2020 "Telemetry Incidents"
- July 14, 2020 "A Thesis on Intrahospital Transports"
- August 4, 2020 "Intravenous Issues"
- February 2021 "Risk from Intrahospital Transfer: Healthcare-Associated Infection"
- May 25, 2021 "Yes, Radiologists Have Handoffs, Too"
- July 2021 "Unique Way to Rapidly Identify Oxygen Flow"
- April 2022 "Safety Issues in Interhospital Transports"
- January 31, 2023 "Alert on Oxygen Cylinder Use"
- June 20, 2023 "What Can Go Wrong on Intrahospital Transport?"

References:

Bocknek LS, Busog DNC, Ratwani RM, et al. Unmasking the Contributing Factors to Oxygen Disruption Events in the Inpatient Environment and Emergency Department. Patient Safety 2024; 6(1): https://patientsafetyj.com/article/117580-unmasking-the-contributing-factors-to-oxygen-disruption-events-in-the-inpatient-environment-and-emergency-department

Pennsylvania Patient Safety Authority. Patient Safety Advisory. Continuity of Oxygen Therapy During Intrahospital Transport. PA PSRS Patient Saf Advis 2005; 2(3): 9-10 https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://patientsafety.pa.gov/ADVISORIES/documents/200509_home.pdf&ved=2ahUKEwjz5762pdWJAxVlEGIAHZMcEDcQFnoECBQQAQ&usg=AOvVaw3vjoLnQIPpCwmeOLobtOIb

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