The Conundrum of Mechanical Ventilation Alarms

Every day, respiratory therapists set mechanical ventilation alarms in an effort to keep patients safe. The alarms provide essential information about patient condition and device function.[1-3] Mechanical ventilation alarm management goals are simple and straightforward: alarms should achieve maximum patient safety while simultaneously reducing nuisance alarms that lead to alarm fatigue.[1,2] The conundrum is to appropriately set and manage alarms in the face of variables that hinder this process. First, alarm availability and terminology are not universal and differ between device manufacturers, making setting mechanical ventilation alarms difficult even in the same facility.[2] Second, there are no evidence-based standards currently available to guide specific alarm settings and management.[1] Alarm management practices, like alarm thresholds, are based on institutional policy and vary between facilities.[2] Lastly, although mechanical ventilation alarms have received the attention of organizations like The Joint Commission and The ECRI Institute, research on the topic is limited, impacting efforts to improve mechanical ventilation alarm management practices.[4,5]

Studies have been conducted to evaluate the quantity and type of mechanical ventilation alarms triggered in various acute care settings.[1] In 2020, Cvach et al[3] reported ventilator alarm data collected over 18 d in 3 different ICUs. In their study, the overall mean number of alarms per ventilator hour was 7 ± 4, and was 6 ± 3, 7 ± 4, 8 ± 2 in the cardiovascular, medical, and neurocritical ICUs, respectively. In the cardiovascular ICU, the mean number of alarms per ventilator hour among the ventilators used was 8 ± 2 for the Puritan Bennet 840 and 6 ± 5 for the Hamilton G5.[3] The increased peak inspiratory pressure (34.3%), increased breathing frequency (12.9%), and low expired mandatory tidal volume (12.9%) alarms were the most commonly identified.[3] In a study evaluating mechanical ventilation alarms in a long-term acute care facility, Dills[6] reported 190 alarms per patient per day.[6] Other studies have described mechanical ventilation alarms as a percentage of total alarms measured in ICUs. Joshi et al[7] reported that mechanical ventilation alarms accounted for 11.7% of all alarms in a neonatal ICU. Lipton et al[8] reported that 42.2% of all alarms in a cardiac ICU were mechanical ventilation alarms.[8] In a 1994 study of false alarms in a pediatric ICU, Lawless et al[9] found that 31% of alarms originated from a mechanical ventilator.

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In this issue of RESPIRATORY CARE, Langga et al[10] address mechanical ventilation alarms in pediatric ICU settings. Citing the overall lack of studies published on mechanical ventilation alarms, particularly in pediatrics, the authors conducted a retrospective review to determine the frequency, prevalence, and causes of mechanical ventilation alarms. The investigators analyzed 110 d of pediatric ICU and pediatric cardiothoracic ICU mechanical ventilation alarm log data from 2 different types of mechanical ventilators. The overall alarm prevalence rate in their study was 22.5 mechanical ventilation alarms per ventilator day per patient. Alarm prevalence rates were higher in the pediatric ICU (24.9 alarms per ventilator day) than in the pediatric cardiothoracic ICU (20.0 alarms per ventilator day). There were differences between what was considered high- and medium-priority alarms between mechanical ventilators in terms of proportions. A key finding in their study, similar to the study by Cvach et al,[3] is that the proportion and cause of alarms varied by the mechanical ventilator and by the ICU.[10]

There are notable limitations of this study, as mentioned by the authors. An important limitation is that there is no standardized method for reporting mechanical ventilation alarms. This lack of standardized reporting makes it difficult to compare findings to other studies and to benchmark alarms among facilities. Also, because manufacturers vary mechanical ventilation alarm options and terminology, it is hard to compare findings between devices. The study was limited to one facility and the devices utilized in their ICUs. That said, the study still provides valuable information about alarm prevalence in the pediatric population.

We know that mechanical ventilation alarm management can be challenging in neonatal, pediatric, and adult populations from available studies to date. Strategies to improve alarm management include targeted education, adoption of assistive technology, and the use of standardized alarm

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policies that account for individual patient characteristics.[2] Education should provide information on setting patient-specific alarm thresholds, alarm priority, and actions to take when alarms occur. Intelligent alarm systems designed to couple alarms, like low tidal volume with low-pressure alarms, may help identify genuine high-priority alarms that require immediate action. Technological advances, such as artificial intelligence, need to be explored as ways to help clinicians distinguish between actionable (ie, life-threatening) alarms that require a quick response from nonactionable (ie, nuisance) alarms that do not.[11] Reducing nuisance alarms can lessen alarm fatigue, a phenomenon that occurs when clinicians become desensitized to audible alarms due to the overwhelming volume.[1]

In addition to adopting and prioritizing strategies to improve alarm management, respiratory therapists and other clinicians involved in mechanical ventilation management need to address gaps in the current literature. In 2019, our ventilation alarms management workgroup made the following 5 research recommendations that pertain to mechanical ventilation alarms:[1]

1. Identify ways for mechanical ventilation alarm systems to notify clinicians when immediate responses are necessary.
2. Identify alarm parameters that provide a safe level of monitoring while reducing nuisance alarms.
3. Identify practical ways of alerting clinicians of actionable alarms when they are away from the patient's bedside.
4. Identify knowledge gaps and competencies needed for clinicians, professional caregivers, or family members responding to mechanical ventilation alarms.
5. Assess mechanical ventilation alarm variations between noninvasive and invasive ventilators and develop strategies for clinicians to identify critical alarms that may device or mode-specific.

Research on mechanical ventilator alarms will serve to increase patient safety and reduce alarm fatigue. Efforts from researchers like Langga and colleagues[10] should be lauded, but further clinical studies are needed as many questions remain. The conundrum of ventilator alarms needs to be solved soon rather than later to improve patient outcomes and reduce the burden of alarms on clinicians.

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